JUL 5 1946

JUNE, 1946 Vol. 123, No. 6

ANNALS of SURGERY

A Monthly Review of Surgical Science and Practice

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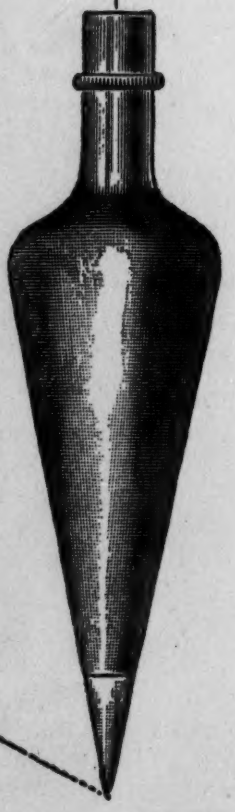

ANGLO-FRENCH Laboratories, Inc.
75 Varick Street, New York 13, N. Y.

ANNALS OF SURGERY

VOL. 123 JUNE, 1946 No. 6

EXARTICULATION OF THE LOWER EXTREMITIES FOR MALIGNANT TUMORS:

HIP JOINT DISARTICULATION (WITH AND WITHOUT DEEP ILIAC DISSECTION) AND SACRO-ILIAC DISARTICULATION (HEMIPELVECTOMY)

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THE MANAGEMENT OF MALIGNANT TUMORS of the extremities often entails amputation. Of the various amputation technics for treating extensive cancers of the extremities, disarticulation of the entire limb in selected cases gives promise of becoming the most effective.

Disarticulation of the shoulder joint is a commonly performed and well-recognized operation which is resorted to more often for traumatic, infectious and other nonneoplastic conditions and will not be considered in this study. Hip joint disarticulation, although less frequently employed, is of distinct value in the treatment of malignant tumors. The present report will deal with its indications, technic and end-results. In addition, the surgical principle of exarticulation of an extremity with excision of the regional lymph nodes for malignant tumors will be introduced, together with a presentation of the indications and technic of hip joint disarticulation combined with deep iliac dissection.

More rarely the shoulder girdle (interscapulothoracic amputation) or the buttock and corresponding innominate bone (sacro-iliac disarticulation) must be included in the amputation if the tumor is to be completely removed. Experiences and end-results with 31 cases of interscapulothoracic amputation, in which the entire upper extremity, clavicle, scapula and their muscular attachments are removed *en masse,* were published by Pack, McNeer and Coley[1] in 1942; this report was but the first of a series of investigations on radical girdle amputations in an effort to evaluate these operations for extensive malignant tumors of the extremities. In the current study the comparable operation for the lower limb—sacro-iliac disarticulation—will be considered.

The present report is based on 25 unselected consecutive cases of hip joint disarticulation, five of which were combined with deep iliac dissection, and six cases of amputation through the sacro-iliac joint. These were performed on

the Mixed Tumor Service of the Memorial Hospital from 1926 to 1945, inclusive. All the operations (including 14 additional interscapulothoracic amputations performed subsequent to the published report of 31 cases in 1942) were carried out for malignant tumors of the extremities without a single operative death. Some of the operations were performed for palliative purposes only, since many of the patients harbored extensive and hopelessly advanced cancers. It will be shown that palliation and comfort, and sometimes a cure, may be anticipated by employing these radical but relatively safe surgical procedures.

PART I.—HIP JOINT DISARTICULATION

Historical.—Amputation through the hip joint is an operation that even now is not undertaken lightly. In the early years of the last century, when sepsis attacked most every wound and anesthesia was unknown, it must have demanded more than ordinary courage for both surgeon and patient. Amputation through the hip joint was first successfully performed by Walter Brachear, of Bardstown, Kentucky, in August, 1806,[2] for a comminuted, compound, multiple fracture of the femur in a 17-year-old mulatto slave boy. A midthigh amputation was carried out, at which time the major vessels were ligated. The bone was then exposed up to the head of the femur on the outer aspect of the thigh and the head of the femur was disarticulated—all of this without anesthesia or antiseptics. Brachear never published an account of his operation.

The earliest recorded instance of a well-conceived surgical amputation through the hip joint was made by Sir Astley Cooper.[3] The operation was performed at Guy's Hospital on January 16, 1824. The patient was a 40-year-old white male whose limb had been amputated just above the knee some years before. The femur had "become diseased from the extremity of the stump to the trochanter major." The actual removal of the limb took 20 minutes, and the ligation of the major vessels and application of a dressing 15 minutes more. The patient became faint during the operation but revived on the administration of wine and admission of fresh air. He bore the operation with extraordinary fortitude. After it was completed, he said to Sir Astley Cooper that it was the hardest day's work he had ever gone through, to which Sir Astley replied that it, too, was almost the hardest he had ever experienced.

The final note on this historic case is as follows: "August, 1825: This patient perfectly recovered, and is now living at the country residence of Sir Astley Cooper."

Many of the early hip joint disarticulations were performed by such famous surgeons as Billroth, Trendelenberg, McBurney, Wyeth, Senn and Halsted.

INDICATIONS FOR AMPUTATION THROUGH THE HIP JOINT

Large malignant tumors of the soft somatic tissues of the middle and upper thigh which cannot be completely removed by wide local excision and for which a high thigh amputation cannot assure an adequate margin are best treated by hip joint disarticulation. When the lower extremity is the seat of a bulky, ulcerated, infected, foul-smelling tumor which involves the upper thigh (malig-

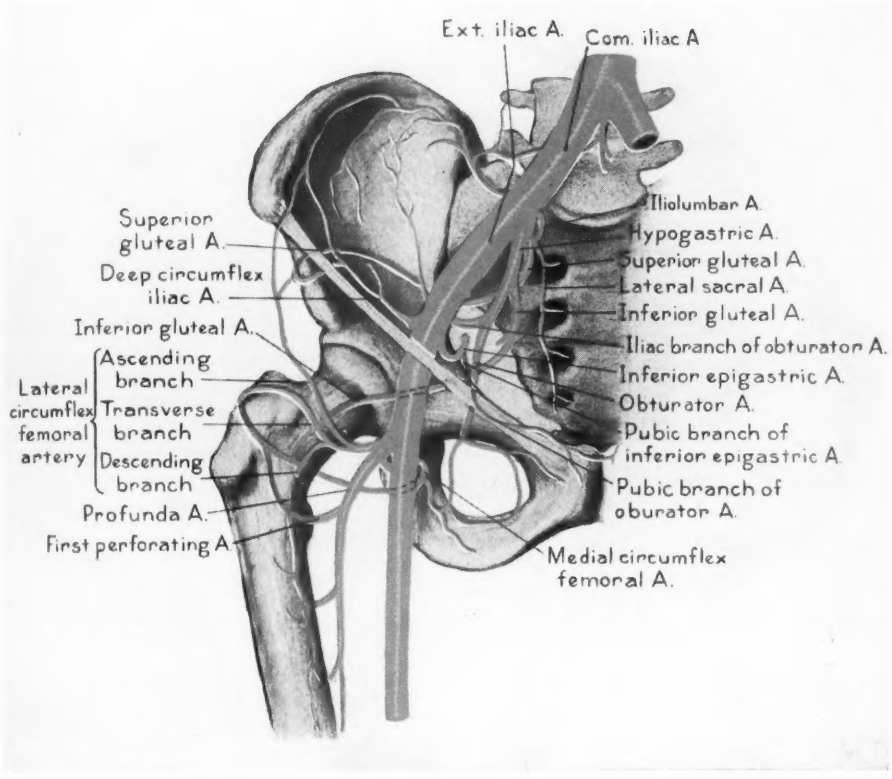

FIG. 1.—Blood supply of the pelvis, showing cruciate anastomosis about hip joint. (Redrawn from Morris, Textbook of Anatomy.)

nant lymphoma, Kaposi's hemorrhagic sarcoma, primary malignant tumor with distant metastasis, and metastatic carcinoma) and the patient's general condition has not deteriorated too much, amputation through the hip joint for palliation and comfort is occasionally justified. Elimination of sepsis and pain, conversion to ambulation and partial activity can only be accomplished in hopelessly advanced cases by radical amputation (Figs. 2 and 4). If exarticulation of the hip joint is performed for either a primary operable malignant tumor or for palliative purposes only, it is requisite that the neoplastic process does not extend to or through the hip joint, otherwise nothing less than amputation through the sacro-iliac joint will suffice.

FIG. 2.—Case 20: Bulky, ulcerated, neurogenic sarcoma with lung metastasis on admission. Patient was bedridden and suffered from intense intractable pain. Hip joint disarticulation was performed for palliation. Note café-au-lait spots, characteristic of von Recklinghausen's neurofibromatosis.

For malignant melanoma of the skin of the lower limb where involved inguinal and femoral lymph nodes are far removed from the primary tumor the principle of "excision and dissection in continuity" cannot be applied.* Under such circumstances only hip joint disarticulation combined with radical groin dissection will accomplish effective removal of the primary tumor, inter-

*_Excision and dissection in continuity_ is a term employed to designate radical excision of the primary tumor, intervening lymphatics and all regional lymph nodes by the same encompassing incisions. A wide removal of contiguous skin and an even wider bloc of underlying fascia are included in the dissection. The surgical principle of excision and dissection in continuity is the same one on which the well-established operations for breast and rectal cancer are based, namely, radical removal in continuity of the primary tumor, intervening lymphatic pathways and the regional lymph nodes in one operative seance.[4]

vening lymphatics and all surgically accessible lymph nodes. Such a combination of surgical procedures will be discussed in a separate section of this report.

Malignant tumors of bone and periosteum which occur in the upper and middle femur and for which high thigh amputation cannot assure an adequate margin should be treated by hip joint disarticulation, provided the hip joint and contiguous structures are not involved by tumor. Endothelial myeloma in such a location should be similarly treated if exhaustive studies have demonstrated absence of this disease elsewhere.

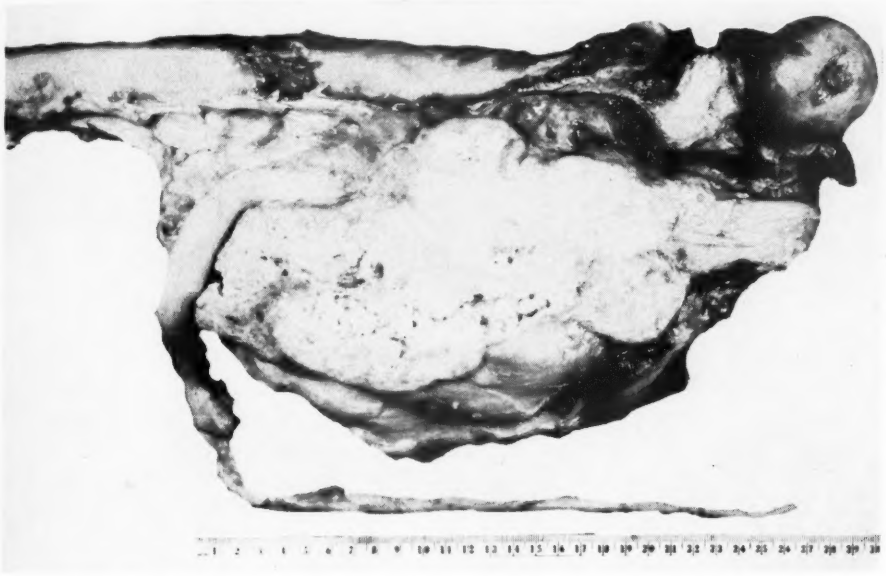

FIG. 3.—Surgical specimen in Case 20. Tumor originated in sciatic nerve.

Neoplasms which extend high up on the thigh and which are destined to undergo malignant transformation, such as a huge plexiform neurofibroma (histologically, containing atypical areas) in cases of von Recklinghausen's neurofibromatosis or a bulky osteochondroma (histologically, containing atypical areas) in cases of multiple cartilaginous exostoses are best treated by removal of the extremity through the hip joint, provided they cannot be excised completely by a more conservative operation.

In this series of 25 hip joint disarticulations, seven were performed for spindle cell sarcoma of undetermined histogenesis; four for neurogenic sarcoma; three each for synovioma, chondrosarcoma and melanoma; two for endothelial myeloma, and one each for rhabdomyosarcoma, reticulum cell sarcoma and liposarcoma (Table I). Five of the operations were knowingly performed for palliative purposes only. In retrospect, as a result of this survey, four of these patients should have been subjected to sacro-iliac disarticulation for curative purposes (Fig. 6).

TABLE I

HIP JOINT DISARTICULATION

Clinical and Pathologic Data of the Memorial Hospital Series

Patient	Age and Sex	Anatomic Diagnosis	Duration of the Tumor	Associated Tumors	Recurrences Prior to Admission	Operation	End-results
1. W. C.	51 M	Neurogenic sarcoma	2 years		3	June 4, 1926	Died suddenly in 6 months, with no evidence of disease
2. B. G.	19 F	Neurogenic sarcoma	5 months	Multiple nevi, neck and ankles	3	Feb. 18, 1931	Living without disease 13 years
3. V. M.	59 M	Neurogenic sarcoma	3 months		2	May 25, 1931	Living without disease 13 years
4. D. M.	23 F	Spindle cell sarcoma of undetermined histogenesis	6 months		1	June 24, 1935, Palliative	Died in 6 months
5. M. H.	9 F	Endothelial myeoma .	7 months		0	Nov. 6, 1936, Palliative	Died in 5 years
6. L. G.	64 M	Chondrosarcoma	6 months	Primary periosteal sarcoma of 4th left rib	0	Jan. 31, 1937	Died in 2 years
7. B. P.*	46 F	Spindle cell sarcoma of undetermined histogenesis	1 month		2	March 27, 1940	Died in 1 year of other causes
8. F. H.	53 M	Spindle cell sarcoma of undetermined histogenesis	2 months		0	May 8, 1941	Died in 1 year
9. M. E.	43 M	Rhabdomyosarcoma	5 months		2	Sept. 3, 1941	Died in 2 years
10. R. M.*	57 M	Melanoma	2 years		2	Aug. 19, 1941	Died in 2 years
11. M. F.	40 M	Spindle cell sarcoma of undetermined histogenesis	7 months		1	Dec. 5, 1941	Died in 1.5 years
12. H. K.	72 M	Reticulum cell sarcoma	1 year	Eosinophilic granuloma of left tibia	3	May 26, 1942, Palliative	Living without disease 3 years
13. J. C.	46 F	Spindle cell sarcoma of undetermined histogenesis	4 months		1	June 15, 1942	Died in 3 months
14. G. C	20 M	Synovioma	6 months		0	Aug. 21, 1942	Died in 1 year
15. A. T.	70 F	Chondrosarcoma	8 months		0	Sept. 15, 1942	Died in 1 year
16. G. W.	21 M	Synovioma	1 year		1	Nov. 21, 1942	Died in 8 months
17. M. C.	32 M	Chondrosarcoma	1 year		0	Apr. 9, 1943	Died in 2 months
18. R. C.	39 M	Spindle cell sarcoma of undetermined histogenesis	1 year		1	March 31, 1944	Died in 9 months
19. S. Z.	58 M	Spindle cell sarcoma of undetermined histogenesis	6 months		1	May 9, 1944, Palliative	Died in 6 months
20. D. C.	33 M	Neurogenic sarcoma	4 months	Multiple neurofibromatosis	2	July 3, 1944, Palliative	Died in 5 months
21. W. M.	38 M	Synovioma	1 year		0	Aug. 21, 1944	Died in 4 months
22. R. C.*	38 F	Melanoma	4 years		4	June 18, 1945	Living without disease 9 months
23. S. F.*	62 F	Melanoma	6 months		1	July 6, 1945	Living without disease 9 months
24. D. D.*	15 F	Endothelial myeloma	9 months		2	Oct. 6, 1945	Living without disease 3 months
25. C. H.*	3 M	Liposarcoma	4 months		1	Oct. 25, 1945	Living without disease 3 month

* Hip joint disarticulation combined with deep iliac dissection.

The youngest patient in this series was 3 years and the oldest 70 years of age.

PREOPERATIVE CONSIDERATIONS

The amount of blood which is contained in one of the lower limbs, even after ligation of the common femoral artery, is considerable. Unfortunately no studies on blood loss estimation were made in any of these cases. Despite meticulous hemostasis and minimal apparent blood loss, shock of varying degrees will occasionally occur just as the specimen is being detached from the patient if other precautions for the conservation of blood are not taken. Shock may here be attributed to a sudden decrease in the circulating volume and can be prevented, for the most part, by constant administration of whole blood during the operation. Use of an elastic bandage wrapped around the limb to be amputated is invaluable in conserving circulating blood volume. It should be carefully applied several hours before the operation is planned. An elastic bandage is definitely contraindicated, however, in cases of melanoma where it might possibly aid in the dissemination of tumor cells into the blood stream.

FIG. 4.—Case 17: Reticulum cell sarcoma involving entire extremity up to femoral trigone, with no evidence of disseminated disease. The process could not be controlled with radiation therapy. Palliative hip joint disarticulation converted a bedridden septic patient into an ambulatory one. No recurrence or metastasis during past three years.

In the event that the tumor is ulcerated and infected, daily local treatment, consisting of gentle débridement, cleansing and antiseptic sprays and frequently applied saline dressings, is of distinct value in reducing the septic condition of the limb. The incidence of postoperative wound infection in this group of cases was decidedly low.

Although vaginal preparation is not as essential as for sacro-iliac disarticulation, the perineal and operative fields can be rendered surgically cleaner by the use of preoperative cleansing douches and antisepsis of the vaginal tube in the operating room, by any of the accepted methods.

A Foley urethral catheter is inserted into the bladder before the patient is taken to the operating room.

							Living without disease 9 months
							Living without disease 9 months
							Living without disease 3 months
							Living without disease 3 month
						June 18, 1945	
						July 6, 1945	
						Oct. 6, 1945	
						Oct. 25, 1945	

ANESTHESIA

Nitrous oxide-ether anesthesia was employed for all cases. In any surgical procedure where a marked drop in blood pressure might occur, spinal anesthesia would not be the anesthetic of choice. Rotation of the patient, which is necessary in exposing the operative field for the posterior dissection, definitely interferes with the technic of spinal anesthesia. In addition, the psychic trauma necessarily induced by a mutilating operation is obviously lessened with the patient asleep. Inhalation anesthesia, be it nitrous oxide-ether or cyclopropane, is to be preferred under the circumstances.

FIG. 5.—Postoperative photograph in Case 17. The absence of an amputation stump following disarticulation of the hip joint makes for prosthetic difficulties. Photograph of prosthesis which is employed in these cases is shown in Figures 12 and 13.

OPERATIVE TECHNIC

The patient is placed on the table with the affected thigh slightly abducted and externally rotated. In the male the scrotum is temporarily sutured to the opposite thigh, which adequately removes the genitals from the operative field.

An anterior racquet incision is the approach of choice. Obviously the amount of skin to be removed might influence the extent and position of the incision. The upper limit of the incision is placed just above the midportion of Poupart's ligament and continued vertically downward for 4 to 5 cm. The lateral limb of the incision is carried downward and outward across the anterior aspect of the thigh coursing just above the greater trochanter. The medial extension of the incision is similarly carried across the thigh in an opposite direction but at a somewhat higher level, corresponding to a point several centimeters below the genitocrural fold. These incisions are joined posteriorly below the infragluteal fold. The posterior incision comes to lie transversely across the thigh (Fig. 7).

The apical portion of the incision is deepened through the subcutaneous tissues and fascia reflecting downward a V-shaped flap. The edge of the inguinal ligament is cleared and the neurovascular bundle is exposed. The femoral artery is removed from its sheath, doubly ligated *above the profunda femoris* and cut. The femoral nerve is delivered and severed* (Fig. 8).

* All major nerve trunks are freed up, injected with one per cent novocaine and divided. Absolute alcohol is then instilled into the stump, which is ligated relatively high.

The incisions are deepened through subcutaneous tissues and fascia in their entirety. Thick skin flaps are developed, medially to the pubes and laterally well above the greater trochanter. The anterior femoral group of muscles (sartorius and rectus femoris) are cut rather low so that they may be later used to cover the acetabulum. All other muscles are severed as near to their insertion as possible. The limb is then abducted and the median femoral group of muscles (gracilis, pectineus, adductors) are transected. The limb is next adducted; the tensor fascia lata is thus put on a stretch and is severed. The femoral vein is finely ligated and divided.* The anterior dissection has now been completed (Fig. 9).

FIG. 6.—An extensive malignant synovioma of the upper thigh which was treated by amputation through the hip joint. Tumor involved tissues contiguous to the hip joint and, in retrospect, this patient should have been subjected to amputation through the sacro-iliac joint.

The limb is again adducted and internally rotated. This maneuver brings the greater tronchanter into view so that the muscles which insert into it may be severed (Fig. 10), after which the gluteal muscle group (gluteals, pyriformis, obturators, quadratus femoris, gamelli) are cut.

The capsule of the hip joint is exposed and made taut by vigorously adducting and internally rotating the limb. After the capsule of the hip joint is incised, further adduction actually forces the head of the femur out of the acetabulum (surgical dislocation). The round ligament is then severed. The head of the femur is drawn forward and outward. The specimen is now attached to the patient by a posterior pedicle consisting of the hamstring

* Ligation of the femoral vein is delayed as long as is feasible to allow the limb to drain itself of as much blood as possible.

muscles and sciatic nerves (Fig. 11-A). These are cut across and the specimen is removed.

The excessive muscular and ligamentous tissue is trimmed. The acetabulum is covered by suturing over the previously prepared muscle flap (sartorius and rectus femoris). The skin flaps are approximated, reshaped if necessary and closed. The wound is appropriately drained (Fig. 11-B).

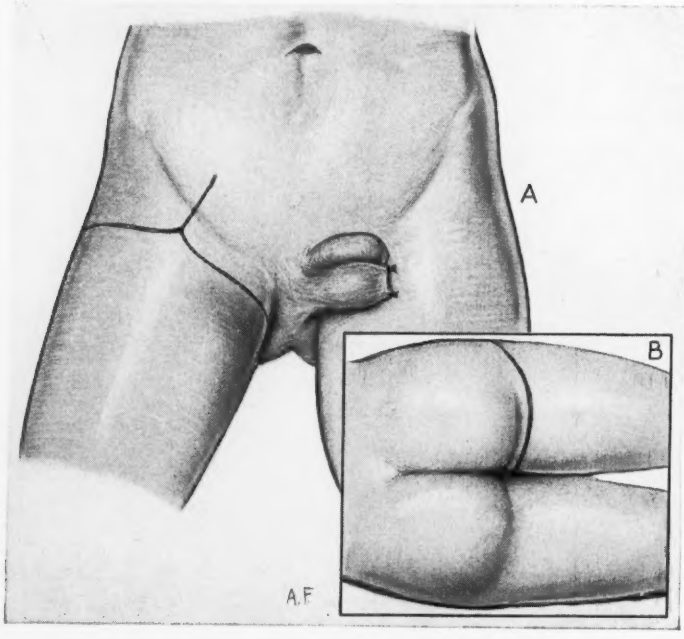

FIG. 7.—(A) Anterior racquet incision for hip joint disarticulation. The upper limit of the incision is placed above the midportion of the inguinal ligament and continued vertically downward for 4 to 5 cm. The lateral limb courses just above the greater trochanter. The medial limb is carried across the thigh at a somewhat higher level, several centimeters below the genitocrural fold.

(B) These incisions are joined posteriorly below the infragluteal fold. The posterior incision comes to lie almost transversely across the thigh.

Control of Hemorrhage.—Numerous devices, such as Wyeth's pin, Senn's clamp, and others, and several maneuvers, such as preliminary ligation of the common iliac artery and digital compression of the abdominal aorta have been suggested for the prevention and control of hemorrhage. These are unnecessary. After secure ligation of the common femoral artery, the main blood supply is satisfactorily controlled. Other branches are clamped as cut during the course of the operation. The only major vessel which might produce troublesome bleeding is the obturator artery which is easily secured even after it has been cut.

COMPLICATIONS

In general, the course following hip joint disarticulation is relatively smooth and uneventful. Severe shock and hemorrhages were not encountered.

Complications such as anemia, urinary retention and abdominal distention, which not infrequently follow amputation through the sacro-iliac joint, did not occur after amputation through the hip joint. The preoperative use of an elastic bandage, delayed ligation of the common femoral vein, administration of blood during the operation, together with meticulous attention to hemostasis, contributed in no small measure to the notable absence of complications.

The patients were out of bed on the second or third postoperative day. Because of the bulky pressure dressing, a retention catheter was placed in the

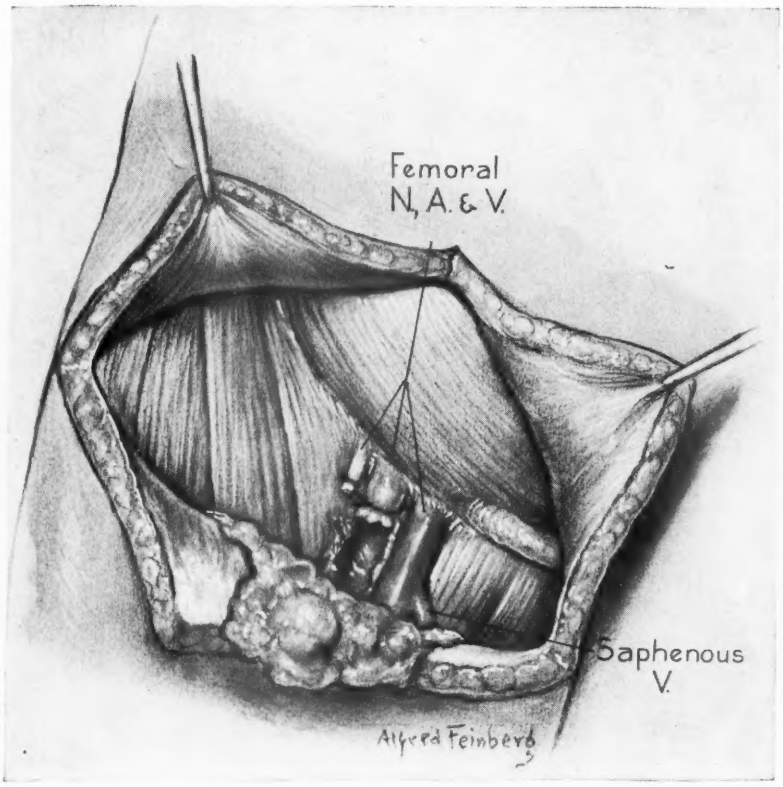

FIG. 8.—The neuromuscular bundle in Scarpa's triangle has been cleared. The femoral artery has been ligated and divided *above its profunda branch.* The femoral nerve has also been transected. Ligation of the femoral vein is delayed as long as is feasible to allow the limb to drain itself of as much blood as possible.

bladder and removed after a lighter dressing was applied (about 48 hours). If the tumor was ulcerated and infected, penicillin was administered for several days postoperatively. If the skin flaps were sufficiently thick and all redundant muscle had been removed from the stump, wound drainage was not prolonged. Drains were shortened on the fifth and removed on the seventh to ninth postoperative days. Frank wound infections were occasionally encountered especially in cases where the tumor was ulcerated and infected and where radical

groin dissection accompanied amputation. In most cases, however, healing occurred *per primam.*

As with amputations elsewhere, stump pain and phantom limb symptoms were not infrequently distressing postoperative complications.

Anemia, which is almost a constant postsurgical manifestation of sacro-iliac disarticulation, did not occur following amputation through the hip joint. The loss of active bone marrow following hip joint disarticulation is not sufficient to interfere significantly with hemopoieses but the amount of additional marrow

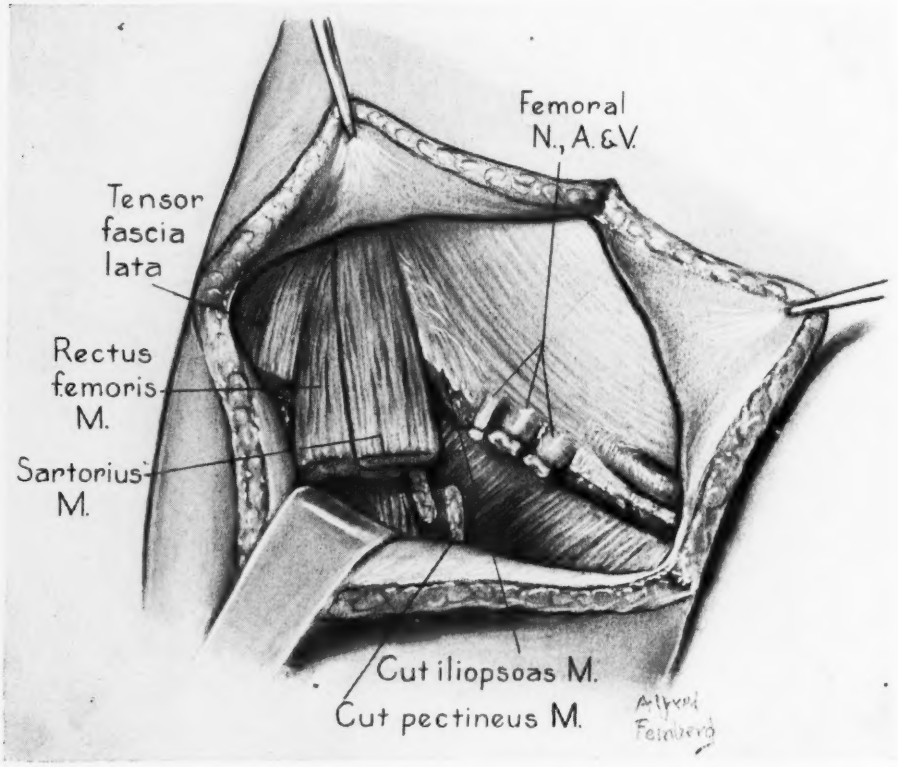

FIG. 9.—The anterior and median femoral muscle groups have been transected. The sartorius and rectus femoris muscles are cut rather low so that they may be later used to cover the acetabulum. The femoral vein is finally ligated and divided, thus, completing the anterior dissection.

contained in the innominate bone might be such that its loss, together with that contained within the long bones of the lower limb, probably results in a resistant but temporary anemia. The anemia which complicates the course of patients subjected to amputation through the sacro-iliac joint will be further discussed in a subsequent section of the present report.

PROSTHESIS

The most unsatisfactory feature of amputation through the hip joint has always been the prosthetic difficulties. Since there is no stump to which the

prosthesis might be attached, it has been customary to secure it about the girth by means of abdominal straps. Patients have found this awkward, cumbersome, and actually distressing. In most instances they have refused to wear them. We have employed a prosthesis which is hung from the shoulders, in addition to abdominal straps (Figs. 12 and 13), so that not only is it more securely and more comfortably attached but, also, the artificial limb can be swung by the corresponding shoulder making walking distinctly easier. The prosthesis and pelvic attachments weigh ten pounds in all. It is worn no more than one or two hours daily for the first few months as patients find it quite tiring.

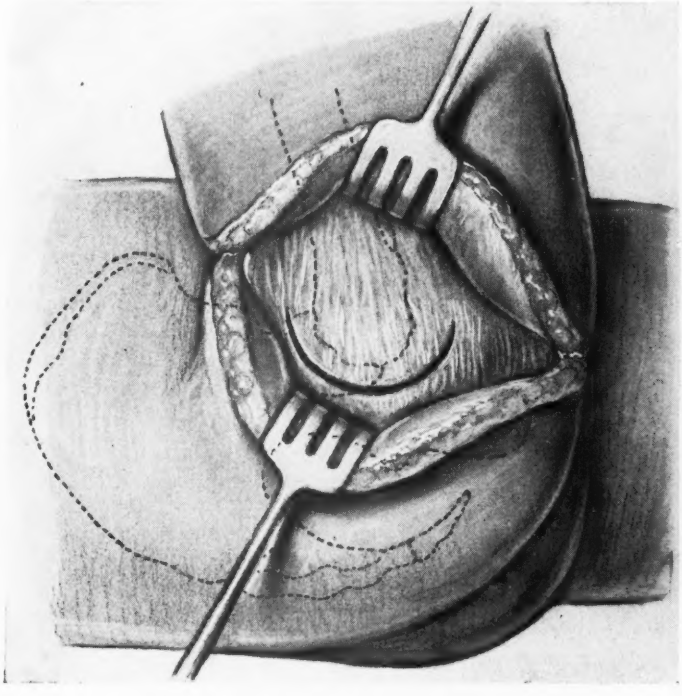

FIG. 10.—Beginning of posterior dissection. The greater trochanter is brought into view by vigorously adducting and internally rotating the extremity. The muscles which insert into it may then be severed.

PROGNOSIS AND END-RESULTS

The prognosis following amputation through the hip joint will depend on the anatomic type of tumor and its extent, the presence of metastasis and the number and variety of previous surgical procedures (local excisions and conservative amputations).

In the present series of 25 cases of hip joint disarticulation for malignant tumors of all varieties and in all stages of the disease, 16 patients died of local recurrence or metastases, making an over-all salvage rate of 30 per cent (Table I). Five of the operations were knowingly done for palliative purposes only,

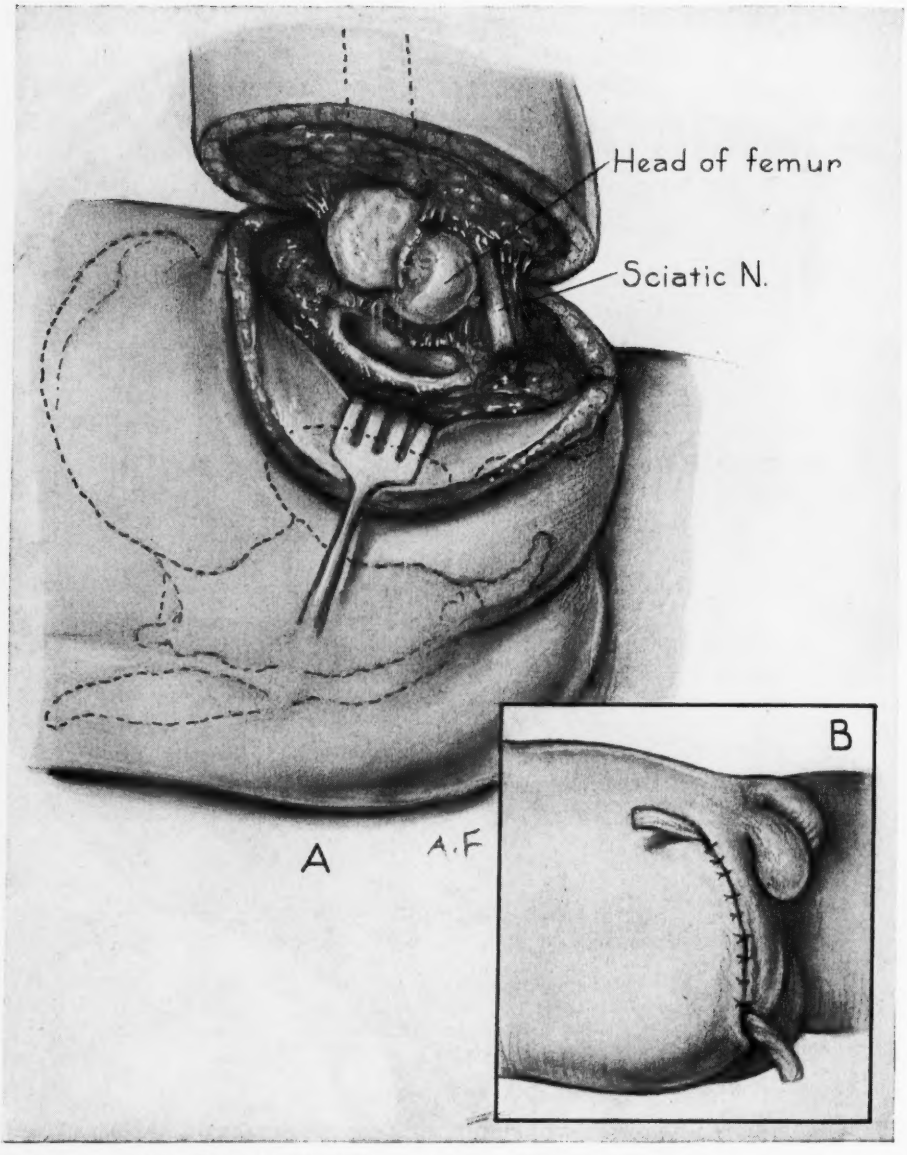

FIG. 11.—(A) Posterior dissection continued. Median femoral group of muscles has been cut. The capsule of the hip joint has been completely incised. By further adducting the limb, the head of the femur is forced out of the acetabulum (surgical dislocation). The round ligament has also been severed. Specimen is now attached to the patient by a posterior pedicle, consisting of sciatic nerves and hamstring muscles.
(B) Wound closure.

indicating a net survival rate at the present writing of 40 per cent. Two patients have remained well for 13 years. In retrospect, four of the patients who had palliative hip joint disarticulations would, at present, be treated by sacro-iliac disarticulation in an attempt to remove the tumor completely. In addition, two of the bone tumor patients would also have been subjected to amputation through the sacro-iliac joint rather than the hip joint in the light of our present knowledge of radical amputations. It is anticipated that such exten-

FIG. 12.—Prosthesis for hip joint disarticulation cases. Note shoulder supports. Pelvic portion is constructed of leather and weighs three pounds. Entire artificial limb weighs ten pounds. This prosthesis may also be employed for cases of hip joint disarticulation combined with deep iliac dissection.

FIG. 13.—Photograph to demonstrate double joint action of prosthesis.

sions of the indications for sacro-iliac disarticulation will eventually raise the net survival rate for both operations.

All but seven of our patients had been subjected to one or more local excisions, and three had undergone conversative amputations prior to the performance of hip joint disarticulation. On admission, all the tumors were bulky and well-advanced. Obviously, these factors unfavorably influence the end-results of the operation. Only when this surgical procedure will be employed in a

selected series of early or moderately advanced previously untreated malignant tumors of the middle or upper thigh will it succeed in appreciably elevating the net survival rate.

The most favorable prognosis was obtained in cases of neurogenic sarcoma, and the most unfavorable in cases of spindle cell sarcoma of undetermined histogenesis. Highly malignant tumors such as synovioma and spindle cell sarcoma are invariably fatal when they are treated by repeated local surgical excisions, no matter how wide. When these tumors occur on the limbs and cannot be completely removed by local excision, primary amputation at an *adequate level* is the patient's only hope for survival. If such a tumor is bulky and situated in the tissues of the middle and upper thigh, nothing less than amputation through the hip joint will suffice. The recent historic dictum "too little and too late" can well be applied to the prevailing conservative attitude of many surgeons toward highly malignant tumors of the soft somatic tissues of the limbs and is to be condemned.

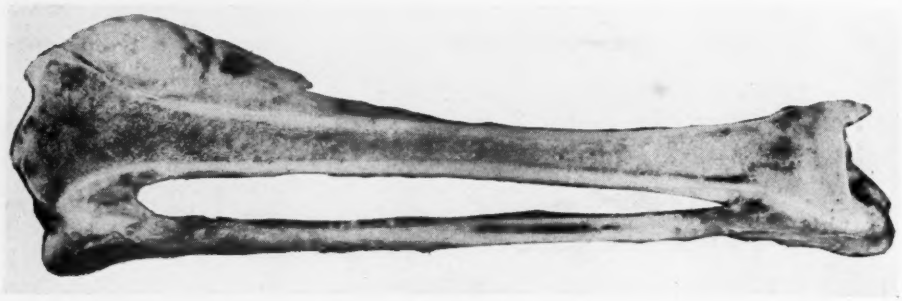

FIG. 14.—Endothelial myeloma of tibia which invaded the soft tissues of the upper leg. A metastasis was also present in the popliteal space. Since the inguinal nodes were involved (proven by aspiration biopsy), hip joint disarticulation combined with deep iliac dissection was performed.

PART II.—HIP JOINT DISARTICULATION COMBINED WITH DEEP ILIAC DISSECTION SURGICAL PRINCIPLES AND INDICATIONS

In the treatment of melanoma of the extremities with demonstrable involvement of the regional lymph nodes, the principle of excision and dissection in continuity should be practiced whenever possible. If the primary tumor is located too far from the first relay of lymph node metastasis, this surgical principle cannot, of course, be employed. In such cases wide surgical excision of the primary lesion subsequently followed by a separate dissection of the regional lymph nodes will only very rarely succeed in removing the intervening lymphatic pathways between the primary tumor and the involved regional lymph nodes making local recurrence or distant metastasis almost inevitable. This conclusion has been reached after many years of surgical experience with over 900 cases of melanoma. In those cases, therefore, where it is technically impossible to excise the primary tumor with sufficient width, together with the intervening lymphatics and involved regional lymph nodes by excision and dissection in continuity, exarticulation of the limb together with removal of the

lymphatic contents of the regional node-bearing space (groin and retroperitoneal space, axilla, *etc.*) is indicated—interscapulothoracic amputation and supraclavicular dissection for the upper extremities and hip joint disarticulation combined with deep iliac dissection for the lower limb.

The operation of interscapulothoracic amputation is ideal for those cases of melanoma of the upper extremity where excision and dissection in continuity cannot be utilized. By employing interscapulothoracic amputation the entire axilla is *excised* rather than entered and dissected, so that all regional

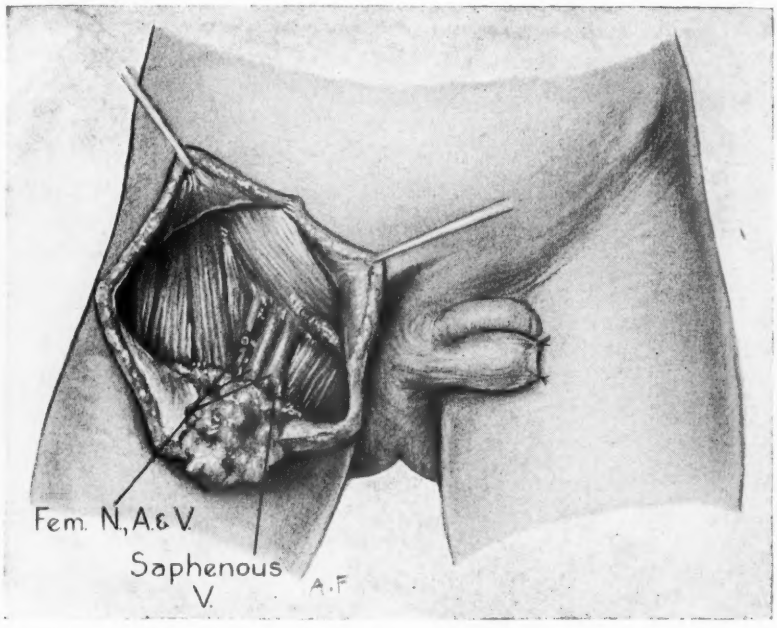

FIG. 15.—Hip joint disarticulation combined with deep iliac dissection. After development of anterior flaps, the lower anterior abdominal wall, inguinal ligament, inguinal canal and Scarpa's triangle are cleared of all fascial, fatty, areolar and lymphatic tissues; this bulk of tissue is dissected downward and is left attached to the specimen. The femoral vessels and nerve may be seen exposed and cleared. First stage of groin dissection completed.

lymph nodes are adequately encompassed and removed *en bloc* without apparently transecting any of the pertinent major lymphatic chains.

We believe that the concept of treating melanoma and metastasizing epitheliomas of the extremities together with the involved regional lymph nodes by excision and dissection in continuity, interscapulothoracic amputation (with neck dissection if necessary) or hip joint disarticulation combined with deep iliac dissection, depending on the anatomic factors which are present, to be surgically sound and to offer the patient his best chance for survival. Radical amputation (disarticulation), including excision of metastatic regional lymph nodes *en bloc*, for selected cases of melanoma is now being employed on the Mixed Tumor Service of the Memorial Hospital. Only after an appreciable number of such operations have been performed as the initial treatment in a

selected group of previously untreated patients and followed postoperatively for an adequate period can these surgical procedures be accurately and finally evaluated.

Other highly malignant neoplasms may not infrequently metastasize to the regional lymph nodes such as spindle cell sarcoma, synovioma and endothelial myeloma. The same surgical principles should be applied in their management as for melanoma (Fig. 14).

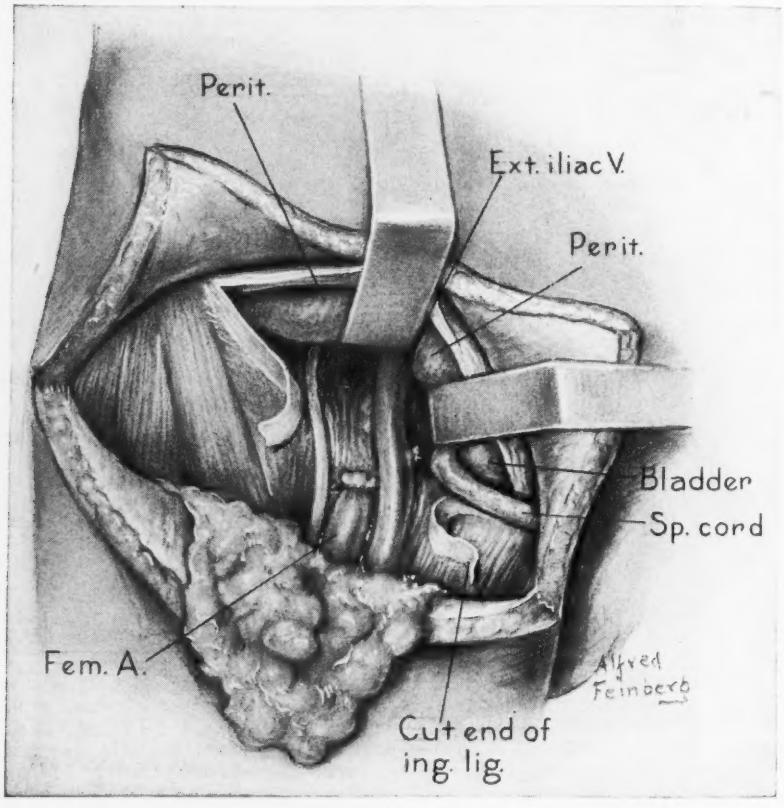

FIG. 16.—The inguinal ligament has been severed. Peritoneum and bladder are retracted upward and medially, exposing the retroperitoneal space and its contents. (In this illustration the deep epigastric vessels have been ligated and divided.) Lymph nodes and fatty, areolar tissue accompanying the external iliac vessels are dissected from above downward. The femoral artery is ligated and divided *above its profunda branch.* This completes the deep iliac dissection (second stage of radical groin dissection) and hip joint amputation may now be proceeded with in the usual manner. Note that ligation and division of the femoral vein is delayed to allow the limb to empty itself of as much blood as possible.

OPERATIVE TECHNIC

The preoperative preparation, anesthesia and other considerations are the same as for amputation through the hip joint. Bladder catheterization should always be done. Since this combined operation is most often performed for melanoma, an elastic bandage is not usually applied, for it might possibly

disseminate tumor cells into the blood stream. The technic of radical groin dissection, as described by Pack and Rekers,[5] is employed, but is altered by omitting the dissection of the upper thigh and Hunter's canal. With this combined operation, a deep iliac dissection is performed and the groin space is actually *excised* rather than dissected, a particularly desirable procedure for the removal of a regional lymphatic basin which contains melanoma.

An anterior racquet incision is made as for hip joint disarticulation but is so modified that the upper extremity of the incision is placed 4 to 5 cm. above and 3 to 4 cm. medial to the anterior superior iliac spine. The apex of the incision lies above the junction of the outer and middle thirds of Poupart's ligament. The anterior portions of the medial and lateral flaps are developed. The skin edges are defined by the scalpel and towels are applied to the wound edges by means of numerous tenacula. These tenacula are very helpful in facilitating subsequent dissection of fat and fascia from the skin because when dealing with melanoma it is important to make the flaps thin. With the tenacula elevated, the subcutaneous fat is dissected widely until the inguinal region and lower abdominal wall over the iliac area have been denuded. The lower flap, roughly shaped like an inverted "V," is reflected downward and need not necessarily be thin as it is part of the surgical specimen. Dissection is started from above downward, removing fascia, fat and lymphatic tissue *en bloc*. The inguinal canal and femoral vessels are exposed and cleared. This bulk of tissue is reflected downward and left attached to the specimen. The first stage of the groin dissection has now been completed (Fig. 15).

The edge of the inguinal ligament is split in its middle. The cut ends of the ligament are retracted and the retroperitoneal space is entered. The deep epigastric artery is frequently not preserved. The peritoneum and abdominal viscera are retracted upward and medially, using deep retractors. Care must be taken at this point not to open the peritoneum or to injure the urinary bladder. This maneuver exposes the iliac vessels and retroperitoneal lymphatic tissues. If necessary, the external oblique and transversalis muscles and fascia can be incised vertically upward, exposing the retroperitoneal space and its contents well beyond the bifurcation of the aorta. The chain of lymph nodes, fat and areolar tissue along the external iliac vessels are dissected from above downward, including those overlying the obturator foramen, and removed *en bloc*. On completion of this deep iliac or second stage of groin dissection, the common femoral artery is doubly ligated and divided *above the profunda femoris*, the outlined incisions are deepened through subcutaneous tissue and fascia in their entirety and the operation of hip joint disarticulation is carried out in the usual manner (Fig. 16).

The wound closure will vary with the amount of skin which has been removed. In most cases the suture line of the approximated skin flaps will be situated on the lateral aspect of the pelvis and stump and will turn medially along the stump toward the perineum. A stab wound is made in the large medial flap, which overlies the lower half of the anterior abdominal wall, through which the wound is drained. A drain is also allowed to emerge through

the most dependent portion of the sutured incision. Because of the extensive thin flaps which have been developed, it is essential that a bulky pressure dressing be applied. These skin flaps, like skin grafts, must be maintained snugly and uniformly against the underlying tissue bed. The pressure dressing should be firm enough to prevent pocketing of serum but not too firm, otherwise necrosis of the flaps will occur.

COMPLICATIONS AND CLINICAL COURSE

The postoperative course, like that following straight amputation through the hip joint, is essentially uneventful except for wound complications. The utilization of extensive and very thin skin flaps with an impoverished blood supply invariably produced a certain amount of skin necrosis along the wound margins, resulting in infections. The inevitable lymphorrhea and pocketing of serum beneath the flaps also encourage infections and contribute to delayed healing.

Meticulous wound care, which should include repeated aspirations through the flaps of accumulated serum and liquefied fat together with the use of a judiciously applied pressure dressing, is an essential feature in the post-surgical management of these cases. The skin margins of the wound usually survive from four to eight days before necrosis becomes manifest and demarcation of the dead skin is established. It is well to wait until the necrosis is fairly complete before proceeding with débridement. As with cases of straight radical groin dissection, patients with appreciable skin defects will require grafting, especially if previous radiation therapy has been given to the area. By administering adequate amounts of penicillin postoperatively and grafting large defects early, the convalescence of patients may be shortened considerably.

The problems of prothesis are similar to those following straight hip joint disarticulation. Apparently the additional procedure of radical groin dissection does not add to the difficulties. The shoulder type of artificial limb is also prescribed in these cases.

PROGNOSIS AND END-RESULTS

In the series of 25 hip joint disarticulations here reported five of the operations were accompanied by deep iliac dissection, an incidence of 20 per cent. Three were performed for melanoma, one for Ewing's endothelial myeloma and one for synovioma. One of the melanoma patients died two years after operation of lung metastasis and one of the patients with synovioma succumbed to massive local recurrence and lung metastasis six months after operation. The other patients are alive and well at the present writing, with no evidence of recurrence or distant metastasis. In retrospect, one of the patients with synovioma should have been subjected to sacro-iliac disarticulation because the bulky mass involved the capsule of the hip joint (Fig. 6).

Our cases are too few at present on which to base a comprehensive discussion of prognosis and end-results for this combination of surgical procedures. However, when melanoma, usually recurrent and frequently associated with satellite tumors, or a comparably highly malignant neoplasm is encountered in

the distal portion of an extremity and the regional lymph nodes are demonstrably involved (positive biopsy), that limb is condemned, for excision and dissection in continuity of the primary tumor, regional lymph nodes and intervening lymphatics is technically impossible. Furthermore, wide local excision of the melanoma followed later by radical dissection of the regional lymphatic basin (groin, axilla, neck) has proven to be inadequate in an experience covering more than 900 cases of melanoma. In order, therefore, to remove the gross limitations of the disease with success, exarticulation of the limb together with excision of the regional lymph nodes (hip joint disarticulation combined with deep iliac dissection, interscapulothoracic amputation with or without neck dissection) must be resorted to if the prognosis and end-results for melanoma and comparable tumors on the extremities with involved regional lymph nodes are to be improved. Most surgeons do not hesitate to amputate radically for osteogenic sarcoma. Is not radical amputation (disarticulation) justified for neoplasms of similar anatomic and clinical behavior if they cannot be adequately removed by a more conservative procedure?

(*To be continued*)

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CHEST WOUNDS IN BATTLE CASUALTIES

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THIS REPORT is concerned with 206 battle wounds involving the thoracic cavity. This group of cases was treated during the period of 24, October, 1944 to 1, March, 1945. A similar group of cases treated between 1, July, 1944 and 24, October, 1944 has been reported previously.[1] Wounds of the chest cavity are classified under four headings which will be discussed separately.

PENETRATING WOUNDS—NOT REQUIRING THORACOTOMY

Eighty-seven casualties had relatively minor wounds involving the chest cavity and required no treatment other than aspiration and débridement of the chest wall wounds. In some, the wounds were so slight as to require only dressings. Three patients classified in this group had hemopneumothorax of such extent that it was felt that aspiration alone would not be adequate; these were treated by closed tube suction drainage. Thoracotomy did not become necessary in any of these cases.

There was one death in this group. The death occurred in a soldier admitted to the hospital with a clostridial infection in a compound fracture of the radius and ulna, in addition to a penetrating chest wound. The arm was amputated and the wound of the chest wall débrided. Death was thought to be caused primarily by the toxemia of the clostridial infection although autopsy revealed extensive intrapulmonary hemorrhage.

PENETRATING WOUNDS—REQUIRING THORACOTOMY

Forty-six patients with penetrating wounds of the chest cavity were subjected to thoracotomy. There were four deaths, a mortality of 8.7 per cent.

At times, it is difficult to decide which patients with penetrating wounds of the chest cavity require thoracotomy. With increasing experience, our tendency has been to be more conservative. In the first group of 87 patients,[1] 42, or 47 per cent, were subjected to thoracotomy, while in the second group of 133 patients, 46, or 34 per cent, were treated by thoracotomy. Minor lung lacerations heal well without suture,[2] and the collection of fluid and air in the pleural cavity can be controlled by repeated aspirations or closed tube drainage. Under the following conditions, it has been our policy to perform a limited thoracotomy through the wound of entrance, or, in some cases, through the wound of exit: (1) When the skin incision necessary for débridement of the chest wall wound caused sucking. (2) When there was extensive damage to the chest wall and roentgenographic evidence suggested severe lung damage. (3) In the presence of progressive bleeding. (4) When large, easily removable foreign bodies were present.

There were four deaths in the group of thoracotomies performed for penetrating wounds of the chest. Three appear to have been due primarily to the amount of lung damage sustained. The fourth death occurred in a patient oper-

ated upon because of a suspected heart injury. A summary of these deaths follows:

TABLE I

WOUNDS OF THE CHEST CAVITY

1, July to 24, October, 1944—24, October, 1944 to 1, March, 1945

	GROUP 1 Previously Reported[1]			GROUP 2 Current Series			TOTALS		
	No.	Deaths	Mortality	No.	Deaths	Mortality	No.	Deaths	Mortality
Penetrating wounds not requiring thoracotomy	45	1	2.2%	87	1	1.1%	132	2	1.4%
Penetrating wounds requiring thoracotomy.	42	2	4.7%	46	4	8.7%	88	6	6.8%
Sucking wounds.....	32	11	34.3%	35	4	11.4%	67	15	22.7%
Thoraco-abdominal wounds.....	36	11	30.5%	38	8	21.0%	74	19	27.0%
Totals.....	155	25	16.1%	206	17	8.2%	361	42	11.5%

Note: Two cases originally reported are not included in Group 1. One was a patient with a tension pneumothorax primarily treated in a Field Hospital, the second was a patient with a crush injury of the chest.

TABLE II

CAUSES OF DEATH FOR COMBINED SERIES

Penetrating wounds—No thoracotomy	2
Intrapleural hemorrhage	1
Gas gangrene of arm	1
Penetrating wounds—Thoracotomy	6
Cardiac failure—during operation	1
Cardiac hemorrhage—during operation	1
Shock	1
Intrapulmonary hemorrhage	1
Pulmonary edema	1
Pleural effusion	1
Sucking wounds	15
Pneumonia	5
Shock	5
Intrapulmonary hemorrhage	3
Respiratory failure—mechanical	2
Congenital diaphragmatic hernia	1
Fracture of sternum	1
Thoraco-abdominal wounds	19
Peritonitis	6
Shock	5
Pneumonia	3
Renal failure	1
Cardiac tamponade	1
Anesthetic	1
Intracranial injury	1
Pancreatic fistula	1

(1) The first death occurred in a soldier with a compound fracture of the right scapula, compound fractures of the second, third and fourth ribs, and a moderately severe laceration of the lung. The chest was explored through the seventh interspace, the blood was aspirated, and a laceration of the lung sutured. This patient died on the third postoperative day of shock and bronchitis.

(2) The second death occurred in a soldier with a penetrating wound of the left shoulder and chest cavity. There were fractures of the fifth and sixth ribs and a partial transection of the spinal cord at the level of the ninth dorsal vertebra. A limited thoracotomy was performed through the wound of entry,

and a severely lacerated lung sutured. This patient died on the second postoperative day. Death was apparently caused by pulmonary edema.

(3) The third death occurred in a soldier with an extensive wound of the chest and fractures of the eighth and ninth ribs. The lung was found to be adherent to the chest wall and so badly lacerated that an adequate suture was not possible. After suture of the chest wound, closed tube drainage was instituted. The patient died on the first postoperative day of intrapulmonary hemorrhage and shock.

(4) The fourth death occurred in a prisoner of war who had a compound fracture of the humerus and a penetrating wound of the chest cavity. This patient did not improve under treatment in the Shock Ward and thoracotomy was undertaken because it was thought that his symptoms might be due to a cardiac tamponade. At operation, no heart injury was found. The arm was immobilized in a plaster spica after débridement of the wound. This patient died on the seventh postoperative day of progressive respiratory failure. Aspiration of the chest had been unsatisfactory due to the presence of the plaster spica, and a large pleural effusion was an important factor in causing death.

SUCKING WOUNDS

Thirty-five sucking wounds of the chest were treated with four deaths, a mortality of 11.4 per cent. These wounds were treated by a débridement which included a resection of the fractured rib ends. The wounds were enlarged enough to allow exploration of the chest cavity and removal of blood clots and foreign bodies. Lacerations of the lung, when present, were sutured. All layers of the chest wall including skin were sutured. The four deaths in this group were caused primarily by shock, the result of blood loss, and disturbed respiratory mechanics. A summary of the four deaths follows:

(1) The first death occurred in a prisoner of war with a sucking wound of the left chest, a laceration of the pericardium and a large hematoma of the lung. Death on the first postoperative day was due to shock.

(2) The second death occurred in a soldier with a sucking wound of the left chest and a wound of the right knee. The blood loss had been large due to lacerations of the internal mammary and popliteal arteries. After what was felt to be adequate blood replacement, the patient was taken to the operating room where he died of shock during the operation.

(3) The third death occurred in a soldier who was admitted, in a state of unconsciousness, with a large sucking wound of the right chest. He showed little response to shock treatment and for this reason the wound was simply débrided and closed, under local (novocaine) anesthesia. This patient died on the second postoperative day without ever fully regaining consciousness.

(4) The fourth death occurred in a soldier with a large sucking wound of the right chest in the posterior axillary line. This patient also was unconscious on admission and did not respond to shock treatment. The wound was closed without anesthesia, but the patient failed to improve, and died on the first postoperative day. This and the preceding case are probably examples of "irreversible shock."

THORACO-ABDOMINAL WOUNDS

Thirty-eight patients were operated upon for thoraco-abdominal wounds. Twenty-two of the wounds were in the right chest and 16 in the left. There were eight deaths, a mortality of 21 per cent. Some of the patients in this group had relatively minor injuries in spite of the fact that the wounding missile had passed into or through both the chest and the abdominal cavities. The surgical approach to these patients depended on whether the major injury was thought to be in the chest or in the abdomen. A wound of the chest which was sucking was always treated before the abdominal injury, and in many cases, it was found that adequate exploration and reparative surgery of the upper abdomen could be done through the diaphragm. In our experience, this was the easiest route through which to remove a spleen. In other cases, where the major injury was obviously in the abdomen, a celiotomy incision was made and a thoracotomy avoided if possible. In wounds of the left chest, the diaphragm was routinely sutured, but we did not always suture the right diaphragm if this procedure required a thoracotomy in addition to the celiotomy.

There were eight deaths in this group; four were due to chest complications, three succumbed to the abdominal injury, and one died from shock. A summary of these cases follows:

(1) The first death occurred in a soldier with a perforating wound of the left elbow, a fracture of the lower end of the humerus, fractures of the 11th and 12th ribs, a laceration of the diaphragm and lacerations of the spleen and stomach. The stomach and diaphragm were sutured but, as the spleen had stopped bleeding, it was not removed. The arm was débrided and placed in a plaster encasement. Death on the third postoperative day was due to pneumonia.

(2) The second death occurred in a soldier with a perforating wound of both chest cavities. The left chest wound was sucking and there were lacerations of the diaphragm and liver, a contusion of the heart, and fractures of the costal cartilages near the sternum. Death occurred on the operating table and was apparently due to shock.

(3) The third death occurred in a soldier with a perforating wound of the right chest through the tenth rib. The diaphragm, liver and kidney were lacerated. The liver was sutured and the kidney packed to control bleeding. Death was caused by pneumonia.

(4) The fourth death occurred in a soldier with a perforating wound of the right chest and lacerations of the diaphragm and liver. The liver was sutured to control bleeding. Death was due to peritonitis and pneumonia.

(5) The fifth death occurred in a soldier with a sucking wound of the left chest and abdomen. The missile entered between the eighth and ninth ribs and lacerated the lung, diaphragm, spleen, stomach and liver. The stomach, spleen and diaphragm were sutured after enlarging the wound of entrance. This patient died on the second postoperative day of respiratory failure. At autopsy, a bilateral pneumothorax was found. There was no wound of the right chest and no satisfactory explanation for the right pneumothorax was discovered.

(6) The sixth death occurred in a soldier with a wound of the right chest

and abdomen. The diaphragm, liver, kidney and colon were lacerated. The kidney was removed, the diaphragm sutured and a loop-colostomy made of the injured colon. The cause of death was bronchopneumonia and pulmonary edema.

(7) The seventh death occurred in a soldier with a wound through the left upper abdomen which injured the spleen, kidney and pancreas. It was not recognized that the missile had entered the pleural cavity. The spleen was removed,

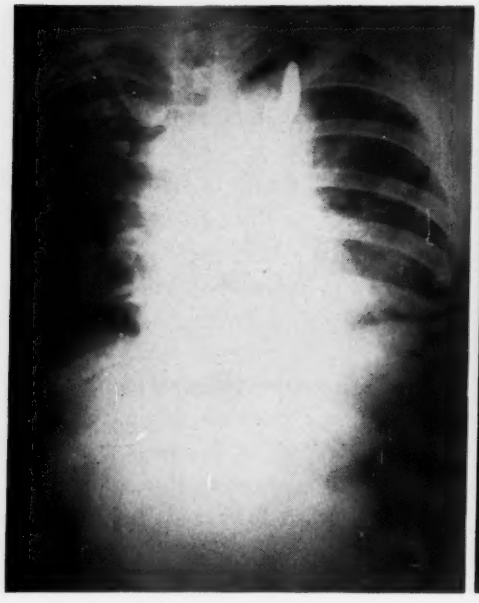

FIG. 1

FIG. 2

FIGS. 1 and 2.—Roentgenograms showing a large shell fragment penetrating the left chest and lung. This patient had minimal respiratory distress on admission to the hospital and was not in shock. Upon removal of the shell fragment, there was brisk bleeding from a branch of the bronchial artery. This was ligated, the laceration of the lung sutured and the chest closed without drainage. The patient made a good recovery.

but nothing was done to the kidney or pancreas since both had stopped bleeding. An empyema developed and was drained. The patient subsequently developed a large fluctuating mass in his left flank. An incision was made from which a large amount of clear fluid drained. At autopsy, it was found that the drainage came from fistulae of both the kidney and pancreas. Profuse drainage followed, and it is probable that the pancreatic fistula was the primary cause of death.

(8) The eighth death occurred in a soldier with a thoraco-abdominal wound of the left side. The chest wound was sucking and the diaphragm, spleen, jejunum and colon were lacerated. The sucking wound was closed and a celiotomy incision made. The spleen was removed, the diaphragm and the perforation of the jejunum sutured and a loop-colostomy made of the injured colon. An empyema developed and was drained. Later, an intra-abdominal abscess

developed and this was also drained. The patient died one month after injury from intra-abdominal and retroperitoneal infection.

INFECTION

There were no infections of the pleural cavity in the group of 157 cases first reported,[1] but six empyemas developed in the second group of 206 cases. The reason for this is not clear for the surgical treatment, and the use of penicillin and sulfadiazine remained essentially the same. Four empyemas developed in patients with thoraco-abdominal wounds, one followed the closure of a sucking wound of the chest, and one followed thoracotomy upon a patient with a penetrating chest wound. There were no known infections in those patients treated by simple débridement and aspiration.

RESULTS

In the 87 penetrating wounds not requiring thoracotomy there was only one death, a mortality of 1.1 per cent (Table I). The penetrating wounds requiring thoracotomy show a mortality of four in 46 cases, or 8.7 per cent. In 35 sucking wounds, there were four deaths, an 11.4 per cent mortality. Eight of the 38 thoraco-abdominal cases died, a mortality of 21 per cent. It will be observed (Table I) that the total mortality in this series is approximately half that of the previous series.

In the two series combined, there is a total of 361 thoracic cases, representing 3.6 per cent of the 10,700 battle casualties treated in the Second Evacuation Hospital between 1, July, 1944 and 1, March, 1945. The total mortality for the combined series of 361 cases was 42, or 11.5 per cent. The 12 casualties with chest wounds who died in the shock ward before operation are not included in these figures.

CONCLUSIONS

The following conclusions are based upon the total experience to date:

1. Small penetrating wounds of the chest cavity are best treated by aspiration alone.

2. Penetrating wounds of the chest cavity require a limited thoracotomy: 1. When the skin incision necessary for débridement of the chest wall wound causes sucking. 2. When there is extensive damage to the chest wall and roentgenographic evidence suggests severe lung damage. 3. In the presence of progressive bleeding. 4. When large easily removable foreign bodies are present.

3. In treating sucking wounds of the chest, the wound should be enlarged enough to allow suture of a laceration of the lung, removal of foreign bodies, and evacuation of blood clots as well as a complete débridement of the chest wall wound.

4. Many thoraco-abdominal wounds can be dealt with through a thoracotomy incision alone. In others, the major injury is in the lower abdomen and these patients require celiotomy after treatment of the chest wound.

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THORACO-ABDOMINAL WOUNDS WITHOUT ABDOMINAL SIGNS

REPORT OF TWO CASES

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THE OPERATIVE TREATMENT of the thoraco-abdominal war wound in the forward echelon hospital poses a difficult problem in judgment because, as DeBakey has pointed out, if either the chest or the abdomen may be attacked primarily, the patient's chances of recovery are very much better than if both must be attacked separately at a single sitting. DeBakey and Carter point out that, in any chest wound, thorough roentgenologic and fluoroscopic examination of the chest and abdomen must be carried out because, in a surprising number, the missile will be found to have entered the abdomen. A recent report of an Evacuation Hospital in the North African Theater shows that 8 per cent of all chest wounds involved the abdomen as well.

The two cases to be presented have three characteristics in common and it is this fact, as well as their unusual nature, that has led to their being reported. First, both presented left-sided thoraco-abdominal wounds involving the stomach, with a generous spillage of gastric contents into the thorax. Second, neither had the slightest sign of surgical pathology in the abdomen, nor any peritoneal contamination. Third, neither had a so-called sucking wound. These cases were seen within ten days of each other, and have led to some rather definite conclusions concerning this type of injury which, we believe, logically explain the absence of abdominal findings. The theory to be set forth is further supported by a case seen five days after the other two, which presented a left-sided thoraco-abdominal wound involving the stomach, just as the other two, but this patient had, in addition, a sucking wound. Operation in this case revealed no gastric contents in the chest but widespread peritoneal contamination, and would seem to lend further credence to our beliefs.

Very frequently the presence or absence of signs of peritoneal contamination, commonly spoken of collectively as "the acute surgical abdomen," is the deciding factor in time, type or extent of operative treatment and may even be the factor which decides for or against any surgery. The time, as well as the extent, of surgery can be extremely important to the patient's prognosis, as is shown by the first case to be reported, and it is in the hope of clarifying a difficult diagnostic point that these cases are reported.

CASE REPORTS

Case 1.—A white American soldier, age 32, entered a forward echelon hospital at 5:00 P. M., December 5, 1944. He had been wounded in action by an enemy shell fragment at 3:20 P.M. that same day. In other words, he was first seen by one of us 1 hr.

FIG. 2.—Case 1: Foreign body at level of diaphragm, but appears to be above it.

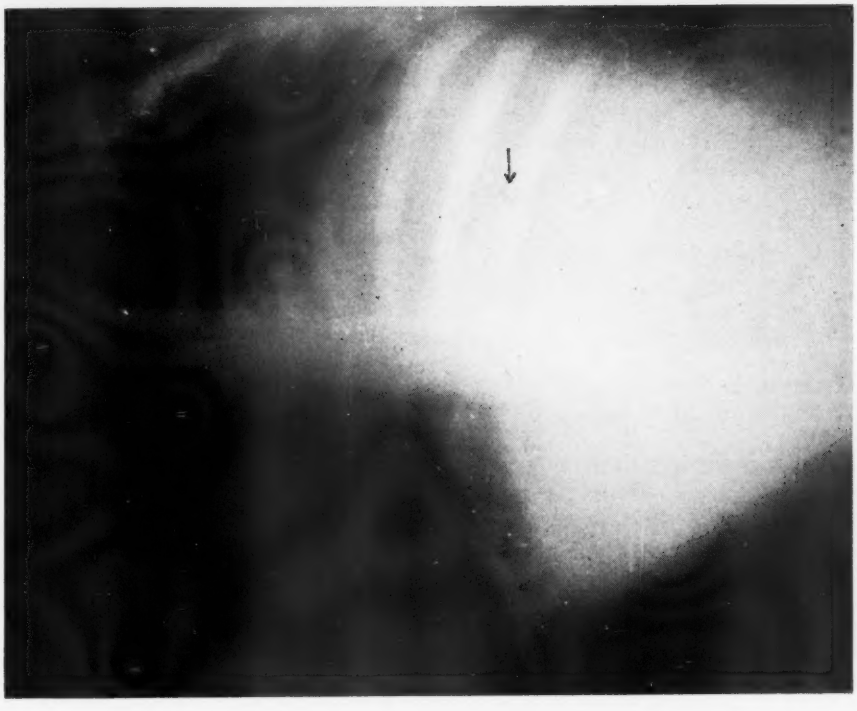

FIG. 1.—Case 1: Showing foreign body (arrow) and widened pericardial shadow.

and 50 min. after he was wounded. Examination revealed the man to be moderately dyspneic, slightly cyanotic, but mentally alert. There was a wound of entrance 8 cm. to the left of the midline in the fourth intercostal space. The wound was 1 cm. in all diameters, and was not sucking. Breath sounds were audible throughout the chest, although decreased over the left base. The pulse was 140, blood pressure 140/110. Heart sounds were very distant and had a slapping character, as if immersed in fluid. The abdomen was entirely negative and bowel sounds were present. Oxygen was started immediately by B. L. B. mask and a small dose of morphine was given.

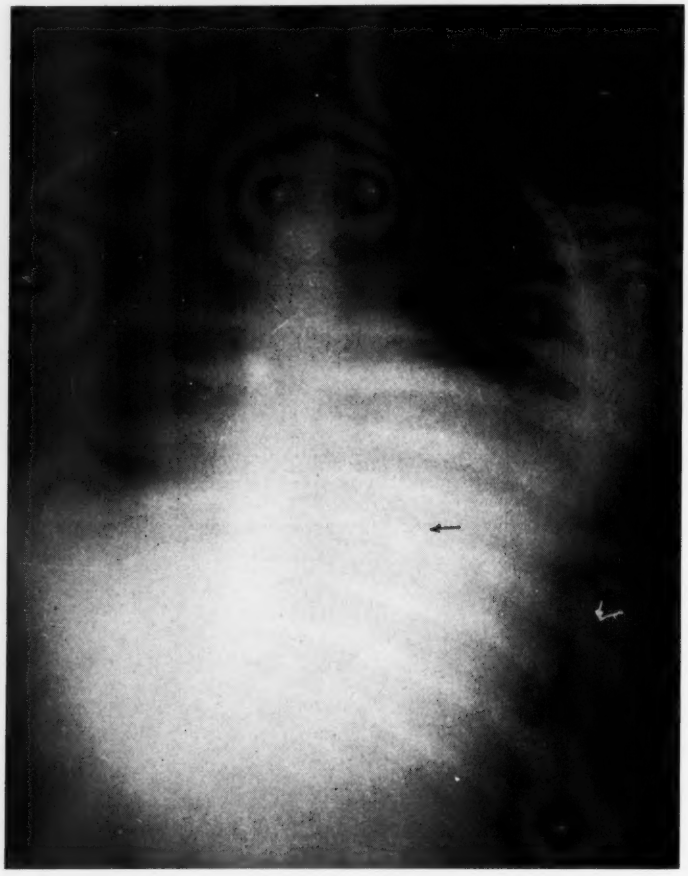

FIG. 3.—Case 1: Showing foreign body (arrow) and further pericardial widening.

A roentgenogram of the chest (Fig. 1) was taken in the 45-degree sitting posture and revealed a small metallic foreign body just to the left of the midline at the level of the ninth interspace. In addition, the heart shadow was widened and the left costophrenic angle was hazy. The greater curvature of the stomach can be outlined on this film and shows rather well the anatomic position of the stomach, a point to be stressed later. A lateral chest roentgenogram gives the foreign body the appearance of being above the diaphragm but in contact with it (Fig. 2).

After careful consideration, it was decided that this man probably had a ventricular cardiac wound, and, since he was handling it rather well, he should have pericardicentesis and no surgery at this time. Reëxamination of the abdomen at this time was again

completely negative. An attempt at pericardicentesis was made but yielded only 75 cc. of blood. However, the patient's blood pressure came down to 132/90, and the pulse fell to 126. He was then returned to the shock ward, watched closely, and given continuous oxygen.

His condition remained unchanged until 10:30 A.M. the next day, and at that time another roentgenogram (Fig. 3) was taken, and was much the same as the previous one except for further widening of the cardiac shadow. Very shortly after this roentgenogram was taken, the patient suffered an acute circulatory collapse and expired at 11:30 A.M., December 6, 1944, 18 hours after entering the hospital. At no time did this patient have any signs of abdominal involvement.

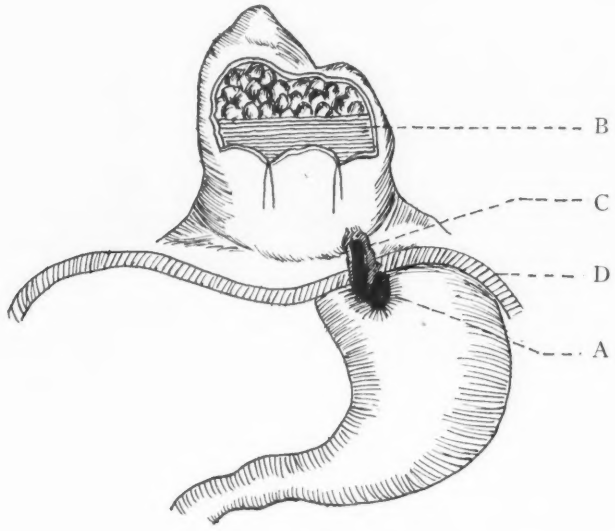

FIG. 4.—Autopsy of Case 1:
(A) Foreign body in wall of stomach.
(B) Opened pericardium showing gastric contents and erosion.
(C) Gastropericardial fistula, traumatic.
(D) Diaphragm.

Autopsy findings were little short of astonishing. As the pericardium was opened, it was found to be half filled with gastric contents (Fig. 4) and the epicardium and parietal pericardium were reddened and eroded, as if by gastric digestion. At the inferior border of the pericardium was a hole 1.5 cm. in diameter continuous with a hole of similar size in the diaphragm which, in turn, was continuous with a hole in the fundus of the stomach, 3 cm. to the left of the cardia. The foreign body was embedded in the gastric mucosa opposite the hole. The margins of the stomach wound were firmly adherent to the diaphragmatic wound and there was no evidence of even minute contamination of the peritoneal cavity. This man then died of a severe chemical pericarditis and surgery was not undertaken because the abdomen was not thought to be involved, inasmuch as there were no signs of abdominal involvement.

Case 2.—A white American soldier, age 22, entered a forward echelon hospital at 6:00 P.M., December 15, 1944. He had been wounded at 3:25 P.M. the same day, 2 hrs. and 35 min. before being seen by one of us. Examination revealed a wound of entrance,

1.5 cm. in all diameters, at the level of the fourth left interspace in the midaxillary line. The wound was not sucking. Breath sounds were absent and percussion dull to flat over the lower half of the left chest. Blood pressure was 124/80, pulse 104. The abdomen was not tender; bowel sounds were present, and there were no signs of intra-abdominal injury. A roentgenogram, however, revealed a rifle bullet at the level of the second lumbar vertebra and 3 cm. to the left of the midline. It was felt that this patient had a thoraco-abdominal wound, with little or no damage to the abdomen. A seventh-rib thoracotomy was performed, and the left pleural space was found to contain 450 cc. of gastric contents (Fig. 5). The visceral pleura of the lower lobe of the left lung and

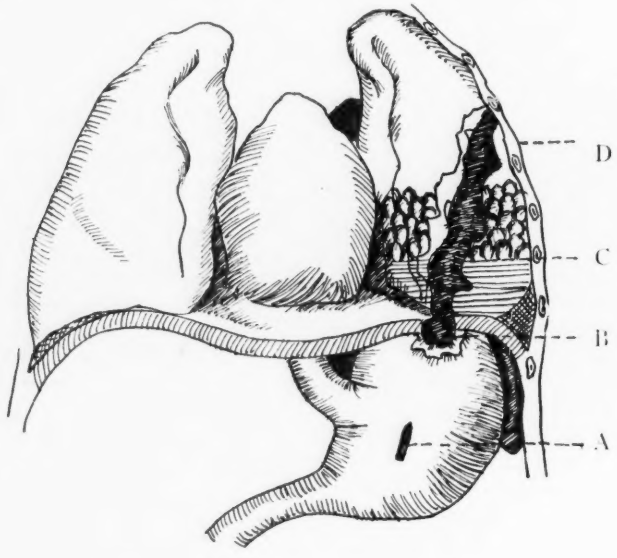

FIG. 5.—Operative findings Case 2:

(A) Rifle bullet in lumen of stomach.
(B) Gastropleural fistula, traumatic.
(C) Gastric contents in pleural space, with erosion.
(D) Point of entrance, closed.

the left diaphragmatic pleura were reddened and eroded, as if by gastric digestion. There was a 2 cm. perforation of the diaphragm, and as this was enlarged to allow exploration of the upper abdomen, a hole in the fundus of the stomach, 2.5 cm. to the left of the cardia, was found adherent to it. The bullet was in the lumen of the stomach. It was removed and the stomach closed.

There was no sign of peritoneal contamination. The diaphragm was closed and the left pleural space was irrigated with 2,000 cc. of warm, sterile, normal saline, which was aspirated. The lung was reëxpanded under visualization by endotracheal positive pressure, and 50,000 units of penicillin solution (10,000 units per cc.) was instilled into the chest. The chest was then closed in layers and a No. 18 F. catheter was placed in the posterior angle of the incision through a stab wound in the latissimus dorsi muscle and attached to a water-seal bottle. The catheter was removed after 48 hours. The patient had an uneventful postoperative convalescence. The lung remained expanded and there were no signs of pleural infection.

The third patient, mentioned previously, had practically the same sort of wound as Case 2, except the wound of entrance was wide open and sucking. This man had widespread contamination of the peritoneal cavity, with no gastric contents in the thorax and, preoperatively, he had a clinically "acute surgical abdomen."

DISCUSSION.—It is immediately obvious that when this particular type of wound is present, the absence of abdominal findings is not rare.

It is an anatomic fact that the fundus of the stomach, from the cardia to that point at which the descending portion of the greater curvature begins, is practically in physical contact with the diaphragm. A sagittal section of the body through the middle of the left clavicle (Fig. 6) demonstrates this fact very well. This portion of the stomach wall follows closely the contour of the concavity of the diaphragm. When a missile enters the left chest, and, either by virtue of small size or an exceedingly oblique course (high point of entrance), fails to produce an open pneumothorax, so-called sucking wound, the internal dynamics of the chest are virtually unchanged. That is to say, the normal negative intrathoracic pressure is unchanged. This, in a normal human subject, in quiet breathing, ranges from minus 6 mm. Hg. in inspiration to minus 2.5 mm. Hg. in expiration. The normal intragastric pressure is plus 6 to plus 10 cm. of water in the upright position, and, even in other positions this pressure rarely, if ever, becomes negative. These are well-established physiologic facts.

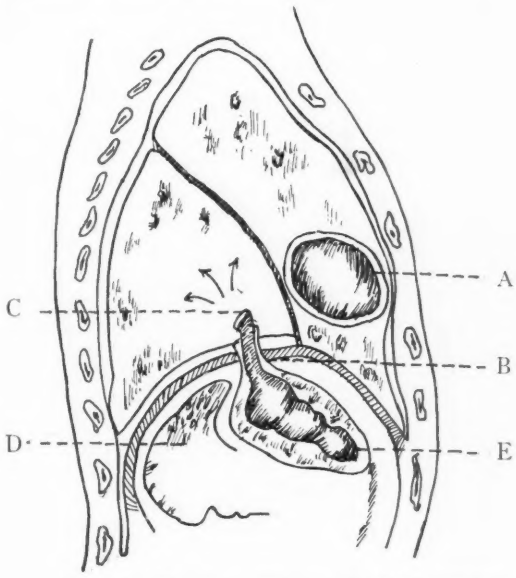

FIG. 6.—Cases 1 and 2: Sagittal section through middle of left clavicle.
(A) Heart.
(B) Stomach sucked against diaphragm.
(C) Gastric contents being evacuated into chest.
(D) Spleen.
(E) Stomach, showing close relationship to diaphragm at this point.

If the missile mentioned above penetrates the diaphragm and that portion of the fundus of the stomach in contact with it, and, further, if the missile stops within the stomach, two cavities, one with a negative pressure and one with a positive pressure, are connected instantaneously. We believe that two things take place (Fig. 6). First, the margins of the stomach wound are literally sucked against the margins of the diaphragmatic wound and held there, and, second, the liquid gastric contents are sucked into the chest. The intrathoracic pressure remains negative in all cycles of respiration, so that

the stomach has no opportunity to pull away from the diaphragm. It is this fact, we believe, which accounts for the complete absence of peritoneal soilage and abdominal signs in this type of injury.

The third case lends credence to this explanation in that, in this patient a wide sucking wound was present, destroying the normally negative intrathoracic pressure, and it was seen that widespread peritoneal contamination resulted. Hence, it follows that when a nonsucking, left-sided thoraco-abdominal wound involving the stomach is present, and the missile remains within the stomach, abdominal signs should not be expected and their absence should not militate against adequate early surgical treatment.

SUMMARY.—Two cases of left-sided, nonsucking, thoraco-abdominal wounds involving the stomach are presented. In both cases gastric contents was present in the chest in sizable quantities. In neither case was there any sign of peritoneal contamination or clinical evidence of abdominal trauma. A physiologic explanation is offered.

CONCLUSION

In this particular type of wound no abdominal signs are to be expected and, again, their absence should not deprive the patient of adequate surgery.

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WOUNDS OF THE URINARY BLADDER

AN ANALYSIS OF 155 CASES

MAJOR LEON M. MICHELS, M.C., A.U.S.

IN THE PERIOD January 1, 1944 to May 8, 1945, the surgical teams of an auxiliary surgical group functioning in the Italian, French and German Theaters operated upon 3,154 wounded individuals having abdominal pathology. One hundred fifty-five of these (4.9 per cent) had bladder lesions. There were 19 additional cases with bladder lesions operated upon in the period, November 8, 1942 to December 31, 1943, but these are not included in this report because insufficient data is available on these early cases of the African and Sicilian Campaigns. These 155 cases were operated upon by approximately 30 different teams, the author being the surgeon of one such group.

The diagnosis of bladder lesions is not difficult. The path of the missile, as determined from an alignment of the wounds of entrance and exit, or from the wound of entrance and the location of the foreign body, as determined roentgenographically, will indicate whether the bladder may have been involved. Fracture of the bony pelvis merit investigation, and, in the occasional case, pressure or blast will damage the bladder. In this series of cases the most frequent sites of entry of the missile were through the buttocks (56 times) and anterior abdominal wall (56 times). Other sites of entry were through the thigh, hip, perineum, back and flank. Approximately one-third of the cases had wounds of exit, the missile having left the body. The missile was retained in the other two-thirds. There is nothing characteristic in the abdominal physical findings. Tenderness, rigidity and peristalsis depend to a large measure on the complicating intra-abdominal lesions and the amount of intra-abdominal or retroperitoneal hemorrhage. The presence of an urinary fistula indicates damage to some portion of the genito-urinary tract, as does hematuria. Clear, normal urine does not contraindicate bladder damage. Five of these 155 cases with lesions of the bladder had no blood in the urine. Six cases had an urinary fistula before operation. Filling the bladder with some solution prior to surgery for diagnostic purpose is not recommended. More contaminated material may be forced into the peritoneal cavity, but more important, extravasation of infected fluid may occur retro- and infraperitoneally. Most of these cases have other abdominal lesions and will be subjected to celiotomy anyway, so it is preferable to wait until the abdomen is opened before instilling saline through an urethral catheter. Any intraperitoneal laceration will then be seen directly. In these 155 cases the correct diagnosis was made preoperatively, or at surgery, 149 times. Six cases were overlooked, two of these died the first postoperative day and the bladder wounds were found at autopsy. Three of the six developed urinary fistula (thigh, abdominal wound, and to the rectum) and were later subjected to cystostomy, with satisfactory results. The sixth overlooked case passed a foreign body per urethra, and recovered following the insertion of an indwelling urethral catheter.

In considering mortality in bladder wounds, it is necessary to realize the high incidence of complicating intestinal pathology. One hundred thirty-four of the 155 cases (86 per cent) had bowel lesions, in addition to the bladder damage. In these cases the gastro-intestinal tract injuries merited and received primary consideration. Even in some which did not involve bowel, hemorrhage from the pelvic blood vessels was more serious than the bladder injury, and certainly presented a greater technical problem. All deaths which occurred in cases with bladder damage were complicated by intestinal injury. The mortality rate in cases having bladder lesions depends mainly on how much bowel damage coexists (Tables I and II). There were no deaths in cases with bladder wounds and no coexisting bowel wounds. This seems to indicate that uncomplicated bladder lacerations which are operated upon promptly are not life-threatening. But it is significant that a multiplicity of lesions increases mortality. The mortality rate for 353 cases with only small bowel lesions operated upon by this auxiliary surgical group was 14 per cent. If the bladder was involved along with small bowel (40 cases) the mortality rate was 22 per cent. Similarly, the percentage mortality for 251 cases with only colon lesions was 23 per cent. For colon and bladder lesions coexisting it was 43 per cent.

TABLE I

PERCENTAGE MORTALITY IN WOUNDS OF THE BLADDER WITH AND WITHOUT COMPLICATING BOWEL LESIONS

	Number of Cases	Died	Percentage Mortality
Total cases with bladder lesions	155	46	30%
Bladder lesions with complicating bowel lesions	134*	46	34%
Bladder lesions without complicating bowel lesions	21	0	0%

* Fifty-five of these 134 involved the rectum.

TABLE II

PERCENTAGE MORTALITY IN WOUNDS OF THE BLADDER WITH COMPLICATING BOWEL LESIONS

Location of Bowel Wound	Number of Cases	Died	Percentage Mortality
Extraperitoneal rectum only	6	1	17%
Intraperitoneal rectum only	17	3	18%
Small bowel only	40	9	22%
Colon only (excludes rectum)	21	9	43%
Both large and small bowel	50	24	48%

The shock-mortality relationship followed the usual pattern. The greater the degree of shock on admission to the hospital, the higher was the mortality rate (mortality rate: 8 per cent no shock, 25 per cent moderate shock and 63 per cent severe shock).

Thirty-five cases were wounded by gunshot, with a mortality of 34 per cent. Seventy-one cases were wounded by shell fragment, with a mortality of 32 per cent. There were three cases of bladder injury classified as due to pressure, with no deaths. In 46 cases the agent causing injury was not recorded.

One hundred thirty-seven of the 155 cases had an intraperitoneal laceration of the bladder. Nine cases had only an extraperitoneal laceration, and none of these died. Nine cases had an extraperitoneal laceration, and one of these

died. Nine cases had a severe contusion, without a laceration. These last nine all had serious other intra-abdominal lesions, and three of them died.

Surgical procedures carried out for bladder wounds varied very little. One hundred and ten cases had a suprapubic cystostomy, with a repair of the laceration; 13 cases had a suprapubic cystostomy, without repair; six cases had repair, without any other procedure; three cases had an indwelling urethral catheter placed; six cases were overlooked; and seven cases died on the operating table. There is no data available concerning the type of surgery done on ten cases. Repair of the laceration with suprapubic cystostomy is the procedure of choice. The abdomen is opened to explore and repair whatever other intraperitoneal injury is present, and the intraperitoneal bladder is thus easily inspected and repaired at the same time. After closing the peritoneum, the extraperitoneal portion of the bladder can be repaired before doing the suprapubic cystostomy. The space of Retzius is regularly drained. In this

TABLE III

POSTOPERATIVE COMPLICATIONS, 109 CASES WITH BLADDER LESIONS THAT LIVED (17 COMPLICATIONS)

Atelectasis	3	Secondary hemorrhage	1
Pneumonia	1	Pyelitis	1
Cardiac failure	1	Epididymitis	1
Fever, unspecified	1	Infected celiotomy wounds (one later eviscerated)	3
Fecal fistula	2	Subphrenic abscess	1
Urinary fistula	1	Abscess, unspecified	1

TABLE IV

ANALYSIS OF DEATHS BY DAY AND CAUSES

Day of Death	Unknown	Misc.*	Shock	Peritonitis	Chest Complications	Anuria	Embolism	Total
Operation	1	4	9	1			1	16
1st postoperative			2	1				3
2nd postoperative	1		4	3	2	1		11
3rd postoperative	1	1		1	1	1		5
4th postoperative		1		1	1	2	1	6
5th postoperative							1	1
6th–8th postoperative	1	1			1		1	4
Total	4	7*	15	7	5	4	4	46

* Miscellaneous deaths: 3 gas gangrene; 2 anesthesia (not definite), 1 heart lesion; 1 retroperitoneal cellulitis

series, sulfonamides were occasionally placed in the abdomen or wound, and in the later cases, penicillin was introduced intra-abdominally. Postoperatively, all patients received sulfonamides orally or intravenously, or penicillin intramuscularly, or both. Three of the nine patients with severe bladder contusions were treated by suprapubic cystostomy (one died), and six received no bladder treatment (two died).

The 109 living cases were followed for from one to 20 days, depending on the tactical situation. Only 25 cases were followed less than five days. There were 17 postoperative complications (Table III), but there was no infection of the paravesicular tissue in any case that lived. There was one retroperitoneal cellulitis in a case that died.

The 46 deaths are analyzed in Table IV. All deaths occurred in cases which had complicating bowel lesions. Early deaths were largely due to shock. Chest complications, urinary suppression and peritonitis were mainly important as immediate causes of death on the 2nd, 3rd and 4th postoperative days. There were three deaths due to gas gangrene of extensive associated wounds.

SUMMARY

Data is presented on 155 cases of bladder lesions incurred as war wounds. The physical findings, shock-mortality relationship and wounding agents are presented. The significance of hematuria is discussed, but cases are listed in which bladder lesions occurred without any blood being present in the urine.

The high incidence of complicating intestinal pathology is shown. All deaths occurred in cases which had bowel lesions in addition to the bladder wound. No bladder lesion uncomplicated by a bowel lesion died, indicating that bladder lesions, promptly operated upon are not necessarily life-threatening. It is shown that the mortality rate for small and large bowel lesions is considerably raised by having a complicating bladder injury, indicating the grave significance of a multiplicity of lesions. The treatment of choice has been the establishment of bladder drainage by a suprapubic cystostomy, with repair of the laceration. The space of Retzius was routinely drained, and sulfonamide and/or penicillin were used both locally and systemically. Only one case developed any postoperative paravesicular infection. The complications and immediate cause of death presented are more related to the complicating bowel lesions than to the urinary tract.

THE SURGICAL TREATMENT OF FUNNEL CHEST*

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FUNNEL CHEST, which, as the name implies, is a funnel-shaped deformity of the anterior chest wall, has been recognized for many years under many names, such as *pectus excavatum, trichterbrust* and *chōnē chondrosternon,* to name a few. Nevertheless, the underlying pathologic condition was not discovered nor a satisfactory operation devised until Brown demonstrated that the deformity was due to a short central tendon of the diaphragm, and described satisfactory surgical treatment. There is an extensive literature on the subject, admirably reviewed by Ochsner and DeBakey, which starts with an article by Bauhinus, in 1594. Since Brown's article appeared Sweet has reported his experience with two cases based on Brown's observations. We are now adding a series of eight cases, the first of which was operated upon two years ago and the most recent one four months ago.

When the deformity is fully developed it is characterized by a deep conical depression of the anterior chest wall the apex of which is at the xiphoid. The sternum shows the greatest displacement. The manubrium is at approximately the normal level but from this point the sternum curves sharply backward until the xiphoid approaches the vertebral bodies. Some cases have been described where the xiphoid was practically in contact with the bodies of the vertebrae, and in our first case the distance separating them was only one centimeter (Fig. 9). The apex of the depression may be in the midline but is often to the right of it, thus, making an asymmetrical funnel. The ribs and costal cartilages attached to the sternum are proportionately involved in the deformity. The ribs tend to flare out laterally and to turn downward and backward at their sternal ends. This is particularly noticeable with the upper ribs and gives a barrel-shape on roentgenologic examination (Fig. 9). The vertebral column is bent forward into an exaggerated dorsal curve (Fig. 8). This, with the chest deformity produces an extreme example of the "round-shouldered, hollow-chested" individual, further heightened by the fact that he is also thin and underdeveloped (Figs. 11 and 12).

The effect of the deformity on the thoracic viscera is that of compression. The lung volume is decreased in proportion to the deformity but seldom to a critical level. The effect on the heart is proportionate to the pressure on it and not necessarily to the degree of deformity. There is frequently a systolic heart murmur, considered to be functional.

Usually, the depression of the sternum pushes the heart into the left hemithorax (Fig. 9) but there may be considerable displacement before the

* Read before the New York Surgical Society, December 12, 1945.

pressure affects the heart action. On the other hand, if the heart is prevented from being displaced a moderate depression of the sternum can produce limitation of heart action. The pressure effect is characterized by dyspnea and palpitation on exertion, which may be so great that the patient is practically bedridden. Furthermore, as with other cardiac defects in infancy and childhood, the nutrition is poor and the physical development retarded. In spite of this, the oxygen saturation of the arterial blood appears to be normal. Often there is a psychologic feeling of inferiority—among the boys when they appear unclothed before their fellows, especially when associated with physical

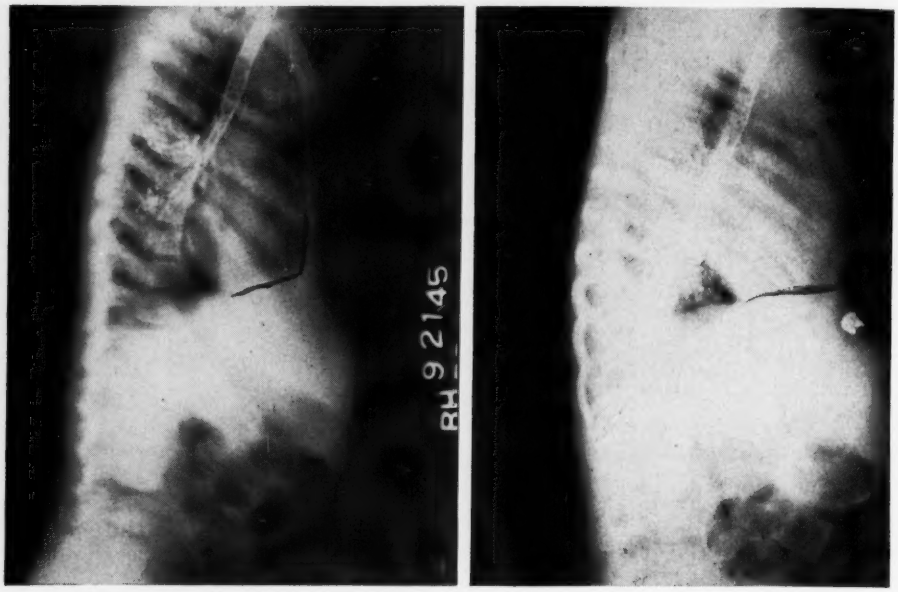

FIG. 1-A FIG. 1-B

FIG. 1.—Lateral roentgenogram of a case of early funnel chest in an infant. The films were taken for another purpose but illustrate the mechanism of funnel chest.

(A) During inspiration: The diaphragm is flattened and the xiphoid retracted.
(B) During expiration: The sternum is in a normal position and the diaphragm somewhat domed.

limitations; and among the girls when they appear in bathing suits or low-necked gowns.

The movement of the thorax during respiration, especially in the vicinity of the deformity, is characteristic of paradoxic respiration. During inspiration the sternum moves backward and the entire funnel deepens, while during expiration the movement is in the opposite direction (Fig. 1). In other words, the movements of the thorax are the reverse of the normal respiratory movements. The explanation of this was discovered by Brown, who noted that the central tendon of the diaphragm was unusually short so that contraction of the muscle exerted a pull on the xiphoid and the costal cartilages of the costal arch drawing them backward (Fig. 1), whereas a normal dia-

phragm by flattening its dome would allow the sternum and ribs to swing out and increase the volume of the chest. This pull on the sternum produces a deformity which is reversible at first, *i.e.,* in early infancy, but when exerted over a long period of time makes the deformity permanent unless corrected.

The permanent deformity is maintained also by the substernal ligament. This is a continuation of the linea alba of the abdomen up along the under surface of the sternum to the suprasternal notch. It is a dense fibrous band closely adherent to the sternum and involved in the attachment of the diaphragm to the xiphoid. In an established case this ligament can maintain the deformity even after the overlying sternum has been resected. Furthermore, it seems to have an abnormal development as a result of the deformity and hence is a structure of great importance in dealing with the correction of the deformity.

The etiology of the deformity is generally considered to be congenital and hereditary. In many cases some other member of the family can be found who has a similar funnel chest and not infrequently several members of the family show the deformity. Other explanations, and there are many of them, have little to recommend their serious consideration with one exception. That is the one which ascribes an obstruction in the respiratory tract as a cause of the deformity.

Dr. L. Emmett Holt, Jr., believes that the shortening of the diaphragm is initiated as a result of forced respiratory efforts to overcome an obstruction somewhere between the carina and the nose or mouth. The negative pressure thus produced causes a depression of the sternum because the cartilaginous portion of the chest is its weakest area. This, in turn, leads to a contracture of the diaphragm which eventually becomes permanent. Certainly respiratory obstruction in an infant, as in the case of pneumonia due to aspiration of amniotic fluid, can produce marked paradoxic respiration with depression of the sternum. Furthermore, four of our cases either had obstruction due to adenoids or gave such a history and one of the infants whose obstruction was unrelieved subsequently developed a depression of his sternum to a certain degree four months after operation. Nevertheless, it is difficult to consider this obstruction as anything other than a contributory cause. Many children have nasal obstruction due to adenoids but few have funnel chest. However, if a child has an obstructive type of breathing the obstruction should be relieved before attempting surgical correction of the funnel chest.

The symptoms and signs just described are not seen in all cases of funnel chest. When they are present operative correction is indicated. Should the patient with obvious funnel chest be without symptoms nothing is to be gained by operation unless the deformity is increasing or the psychologic state suffers as a result of it. Then, even without symptoms, I believe operation is justified. When the deformity is noticed at birth or during infancy there is no indication as to the extent to which it may increase in the future. The condition is reversible at this time and the operation relatively simple. Hence, whether or not symptoms due to funnel chest are manifest every case in an infant which

shows a well-defined tendency to funnel chest should be treated by surgical means, provided any respiratory obstruction has been relieved.

The surgical treatment is of two types: The first, and more simple, is for the early stages of the deformity in infancy and is contrived to release the pull of the diaphragm on the sternum and costal arch. The other is designed to correct a deformity which has been established and must not only release the diaphragmatic pull but must also correct the bony deformity which

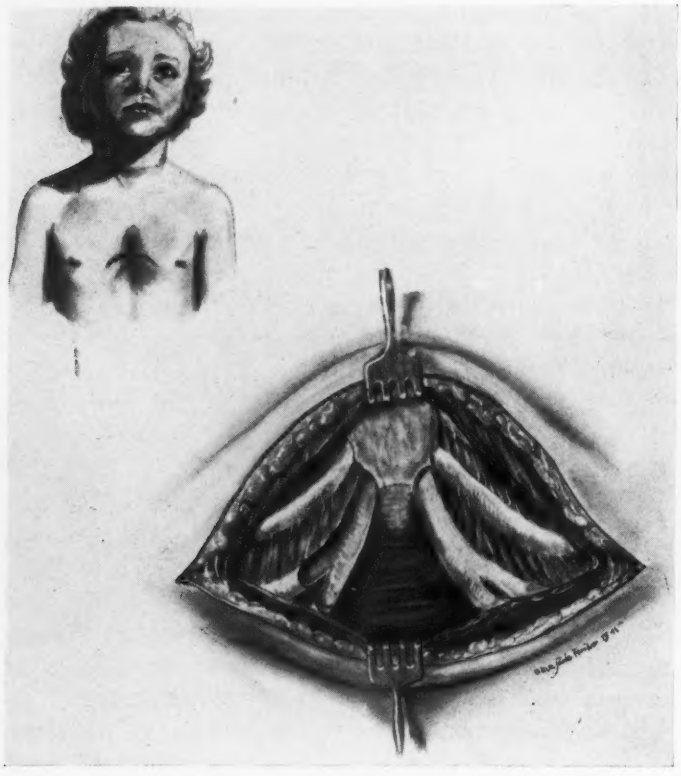

FIG. 2.—The simple operation when the deformity is reversible: The lowest costal cartilage attached to one side of the sternum has been resected showing the depressed xiphoid. Insert shows the incision.

has resulted from this pull. It is obviously a much more extensive procedure. In the main, we have followed the principles and technic described by Brown, but have made some modifications which will be described.

In the first, or reversible group, there are three cases, two infants and the third in a child in her fifth year. In the last case pressure symptoms were beginning to develop and the deformity was established but moderate and we expect that with the pull of the diaphragm released the deformity will disappear as the child grows. In this our expectations are being realized. Two results were entirely satisfactory but one, after several months of satisfactory

progress, again developed serious respiratory obstruction with a partial return of his deformity.

A curved incision is made about one centimeter above the costal arch with the convexity of the curve cephalad and crossing the midline of the sternum at the highest point of the incision. The skin and subcutaneous

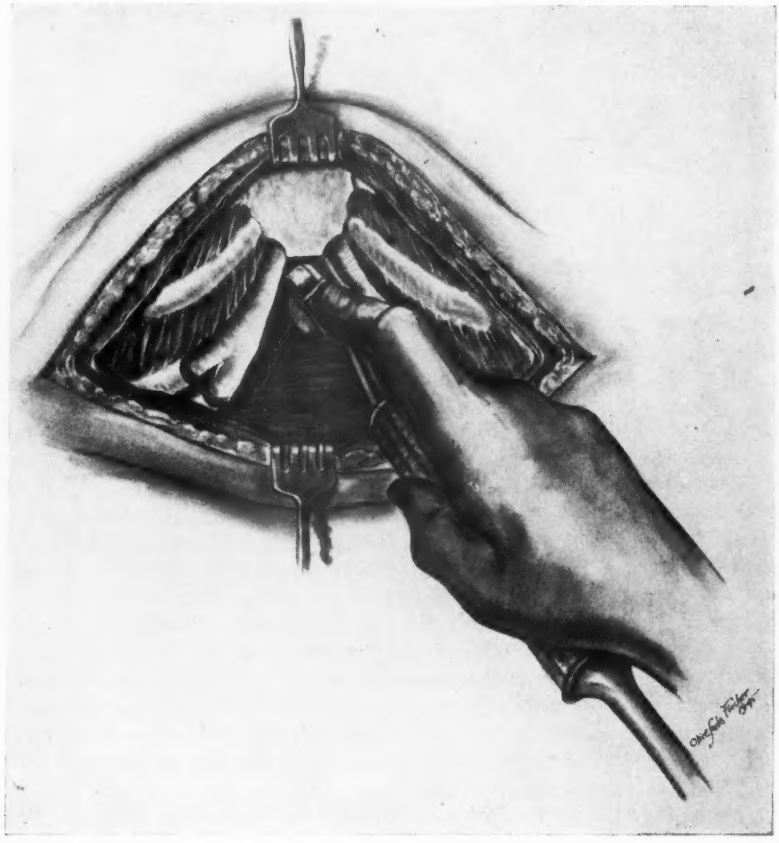

FIG. 3.—The simple operation. The lowest costal cartilage on each side has been resected and the xiphoid separated from the gladiolus, transecting the substernal ligament at the same time. The periosteal elevator is being used to separate the diaphragm from the resected cartilages. Following this the wound will be closed.

tissues of the lower flap are dissected back exposing the two lowest costal cartilages at their sternal ends (Fig. 2). Subperiosteal resection is then performed on the lowest cartilage on each side of the sternum, usually the fused sixth and seventh. Resection is advisable because the opposite cartilages approach each other so closely as a result of the deformity that they cover the xiphoid and make it inaccessible. When they have been resected the lower end of the sternum can be caught with forceps and pulled up, thus exposing the junction of xiphoid and gladiolus. The union is fibrous and is

readily severed with a transverse incision, allowing the diaphragm to pull the xiphoid sharply back. This exposes the substernal ligament, unless, as often happens, the substernal ligament is divided when the xiphoid and gladiolus are separated. Should the ligament remain intact it is severed separately allowing further retraction of the xiphoid and permitting entrance to the ventral mediastinum. A periosteal elevator or similar instrument is next inserted into this space and the diaphragmatic attachments separated from the resected portions of the costal cartilages (Fig. 3). This allows the sternum to spring up to its normal position or at least to approach it. The wound is then closed without drainage.

CASE REPORTS

Case 1.—M. S., male, six months old, was admitted to the Pediatric Service of Bellevue Hospital, January, 1944, with an acute upper respiratory infection and malnutrition. Aside from frequent colds and coughs he had suffered no illness. At the time of admission he was an anemic undernourished baby. Tonsils were large. There was an acute upper respiratory infection and an associated bronchitis. The increased respiratory effort occasioned by this disease accentuated a funnel deformity of the chest which was not particularly noticeable during quiet breathing. The lower end of the sternum was pulled in sharply during inspiration and relaxed during expiration. When the pulmonary infection had subsided the baby was sent home to await the disappearance of the upper respiratory infection. He was readmitted, in June, 1944, to the Children's Surgical Service for correction of the funnel chest deformity which had become more pronounced during this time. Operation was performed July, 1944. A curved incision was made over the costal arch. The xiphoid was recognized with some difficulty because of the depression and the tendency of the adjacent costal cartilages to meet and obscure it. With great care the xiphoid was severed from the sternum, which allowed the sternum to spring up into a normal position while the xiphoid was drawn backward. A periosteal elevator was then inserted in the opening and the diaphragm pushed off the mesial ends of the costal cartilages. The wound was closed with silk, without drain. Recovery was without incident. The baby has been observed at intervals. Sixteen months after operation the sternum was in a normal position and the respiratory movements were normal. Removal of the tonsils and adenoids has just been done to relieve the frequent upper respiratory infections.

Case 2.—G. B., a 16-month-old baby, was admitted to Bellevue Hospital, Pediatric Service, May 15, 1945, with the chief complaint of noisy breathing since birth. His mother cared for him until he was four months old and then boarded him out until he was a year old. During that time his diet was probably deficient as he was weak and underdeveloped when she took him back. The baby has had frequent colds and has had measles and chicken pox.

On examination, the baby appeared undernourished. He breathed with an audible stridor and at times seemed to have a spastic convulsion. Tonsils were small but adenoids large. Heart, lungs and abdomen were normal. The chest showed a typical funnel deformity, the apex being at the xiphoid which was further retracted with each inspiration.

Blood count, blood chemistry and urine were essentially normal; Wassermann, negative. Roentgenograms of chest showed no abnormality of lung fields. Patch test for tuberculosis was negative. Direct laryngoscopy showed a large epiglottis somewhat bent on itself but otherwise was normal.

Adenoidectomy was performed two weeks after admission. Recovery was uneventful. The stridor and retraction of the sternum were not materially affected.

Two weeks after adenoidectomy operation was performed on the funnel chest. Curved incision was made over the costal arch and the fused sixth and seventh cartilages exposed. The xiphoid could not be identified. Subperiosteal resection was done of the fused cartilages on each side after which the xiphoid could be recognized. It was separated from the sternum by cutting the attachments and at the same time severing the substernal ligament. This allowed the sternum to spring up as the diaphragm pulled the xiphoid back, thus giving access to the uncovered space in the anterior mediastinum. The diaphragm was stripped from its attachment to the resected cartilages in this space and the wound closed without drainage. The child was returned to bed and placed in an oxygen tent. Drop-ether was the anesthetic.

Following operation the immediate condition was good. The first day after operation a serous discharge was noted on the dressing. This persisted for four weeks and eventually ceased when a catgut suture was removed from the wound.

Spastic convulsions and later spasticity of the right side appeared the day after operation and persisted for several days. Convulsions ceased after that but the spasticity disappeared much more slowly and was intermittently present on discharge four weeks after operation.

Follow-up at three months showed the wound well healed. There was no retraction of the sternum on breathing and the funnel deformity had disappeared. Noisy breathing occurred when the child had a cold but not otherwise. There was a partial paralysis of the right side. Two months later stridor was present all the time and with forced inspiration there was some slight retraction of the sternum as a whole and not of the lower end alone as before operation. The child has gained weight and, except for his slight paralysis is much better than before operation.

Case 3.—C. C., a white girl, five years of age, was admitted to the Hospital for Special Surgery, March 20, 1944, with the complaint of poor posture, funnel chest and underdevelopment. There are no other funnel chest deformities in the family although all have a poor posture and another child has a pigeon breast deformity.

The birth history was not unusual. The mother noticed a funnel chest deformity when the baby was born and this has gradually increased and with it an exaggerated dorsal curve of the spine has developed. The child has not developed properly, gains weight slowly and becomes dyspneic on exertion. She is a mouth breather and has frequent colds.

Physical examination shows a poorly developed girl of five years. Tonsils and adenoids are enlarged. There is a funnel-shaped deformity of the anterior chest wall involving the sternum and adjacent costal cartilages which deepens during inspiration. The apex of the funnel corresponds to the xiphoid, which on roentgenologic examination is three centimeters from the vertebral column (Fig. 8). The heart is displaced somewhat to the left but is otherwise not abnormal. The remainder of the physical examination is essentially normal except for the presence of an acute upper respiratory infection on admission. This necessitated deferring the operation for a week.

Operation was performed, April 1, 1944, under drop-ether anesthesia. A curved incision was made over the costal arch and the sixth and seventh costal cartilages on each side exposed and a subperiosteal resection performed on them. The attachment of the xiphoid to the gladiolus was severed exposing the substernal ligament which was then divided. The diaphragmatic attachments to the resected cartilages were then freed with a periosteal elevator and the gladiolus allowed to spring up. It did not attain a normal position but did come up enough to relieve any pressure on the heart. The wound was closed without drainage.

Convalescence was uncomplicated. The wound healed by primary union, and the child was ready for discharge on the twelfth postoperative day. Postoperative roentgenograms showed little change in the distance between vertebrae and sternum but the dorsal curve had straightened into normal position (Fig. 8).

Eight months after operation the child was readmitted for removal of tonsils and

adenoids, which was accomplished without incident. Eighteen months after operation she was in excellent general condition, there was no dyspnea on exertion and she was gaining weight in a satisfactory manner. The funnel depression, although still present, was less marked and seemed to be correcting itself. There was no pull on it during inspiration.

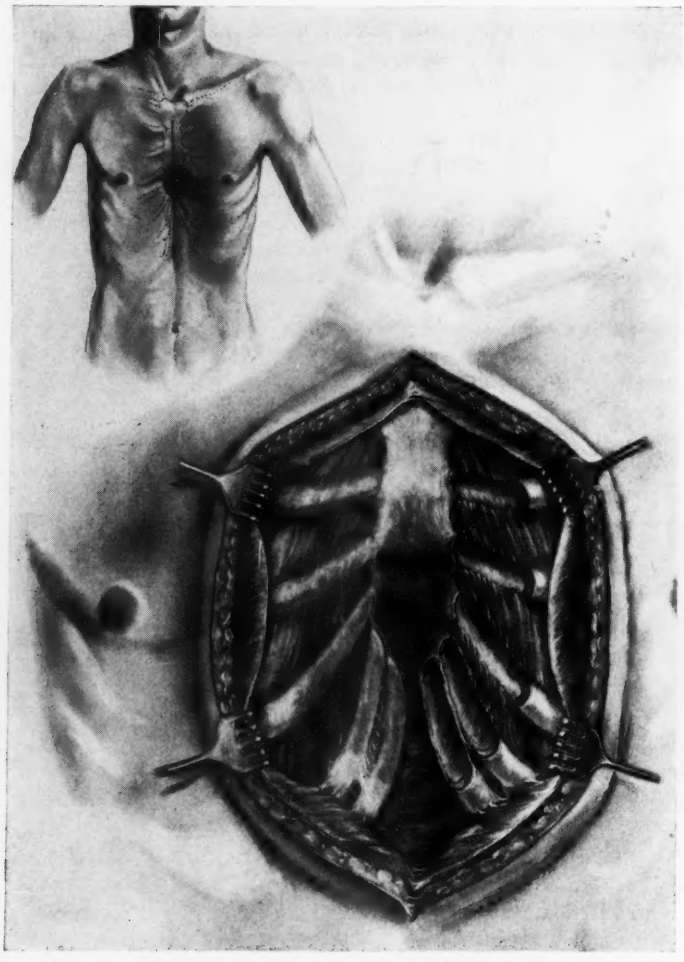

FIG. 4.—The radical operation for established deformity: The cartilages attaching to one side of the sternum, up to the second, have been resected back to the bony ribs and the xiphoid exposed. Insert shows the incision.

COMMENT.—These are cases representing the relief of the deformity by a simple type of operation. The appearance of the depression in the second case may be ascribed to the recurrence of the respiratory obstruction and it is not a recurrence of the funnel chest, but we have classed it as not entirely satisfactory. An established deformity cannot be corrected by this type of operation but if it is minimal it may be expected to improve with the growth of the child if the diaphragmatic pull is relieved.

The fully developed deformity requires a much more extensive procedure for its correction. Release of the diaphragm must be accomplished by separating the xiphoid from the gladiolus, severing the substernal ligament and freeing the anterior midline attachments to the diaphragm from the costal arch as in the simple operation just described. This, however, does not allow the sternum to assume a normal position. For this to be accomplished it is necessary to resect the costal cartilages and transect the gladiolus just below

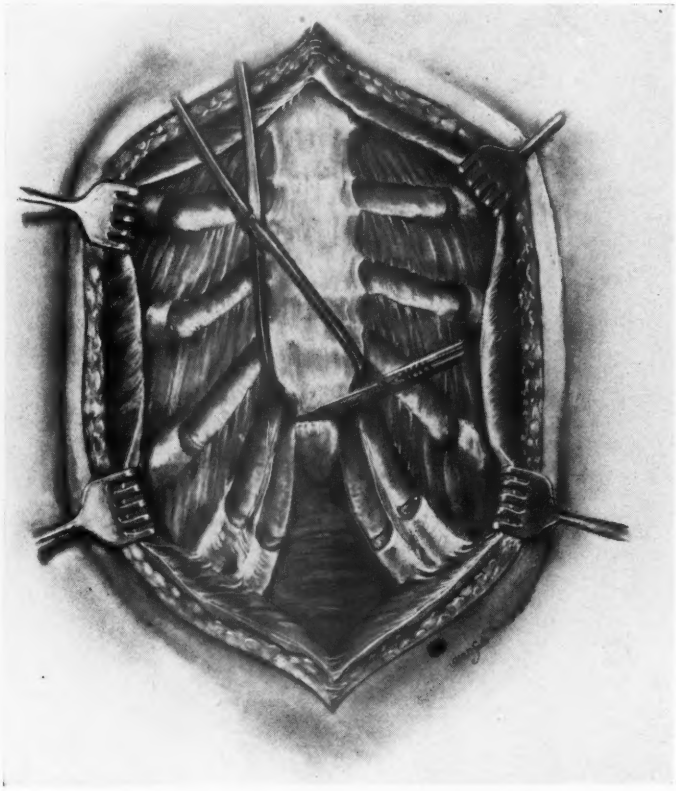

FIG. 5.—The radical operation: The costal cartilages on both sides have been resected and the xiphoid is about to be severed after elevation of the sternum with forceps demonstrates the junction of xiphoid and gladiolus. The substernal ligament will be severed at the same time.

the manubrium, raise the sternum and then maintain it in its new position, until it has become stabilized, by means of an external appliance which Brown calls a Jacob's ladder.

Our first two cases were treated according to the technic described by Brown, with resection of about two centimeters of the costal cartilages and stabilization of the sternum by wiring it to the resected ends of one of the lower cartilages, the wire then being taken out through the skin and fastened into the Jacob's ladder. Dramatic relief was afforded in one case with partial

correction of the deformity. In the other case symptoms were relieved but the deformity recurred, although to a lesser extent than originally. The third case was operated upon with Sweet's modification, which sutures the sternum to the resected cartilages on both sides. Somewhat better correction of the

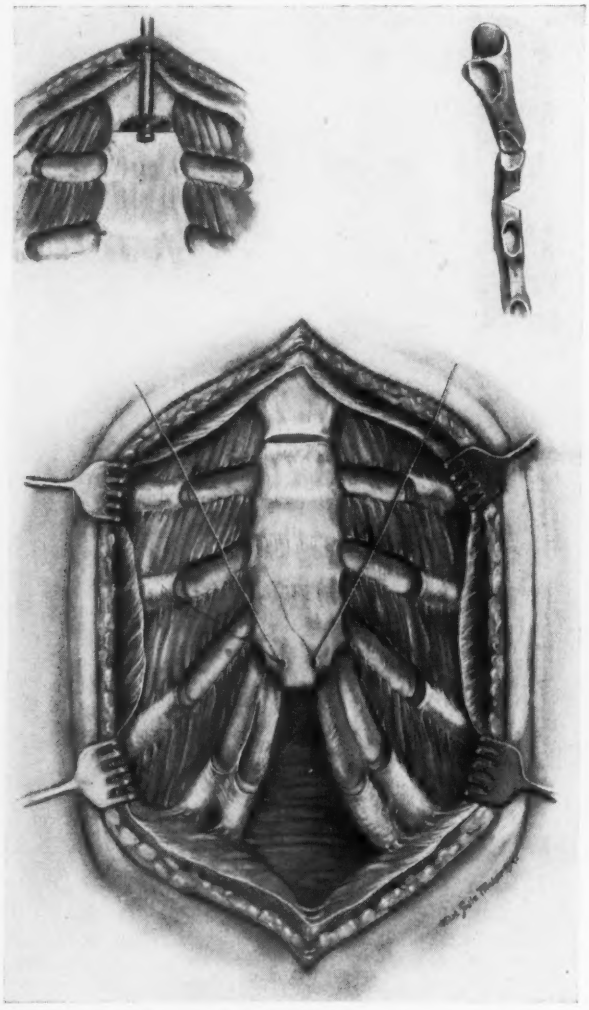

FIG. 6.—The radical operation: The outer table of the sternum has been cut transversely just below the second rib (wedge osteotomy indicated in inserts) and silver wire threaded through drill holes in the lower end of the sternum.

deformity was obtained and the pressure symptoms relieved although the heart murmur persisted.

It is to be noted that in none of these cases was the deformity completely corrected, actually not more than 75 per cent in the best. To achieve complete correction it is necessary to perform a subperichondrial resection of the costal

cartilages back to the point where the rib begins to deviate from its normal course and to similarly resect a portion of the rib also if that be required. Regeneration of the costal cartilage and rib will then take place with the rib in a more or less normal position. This, of course, precludes the possibility of stabilizing the sternum by any suture to the rib ends. However, stability can be obtained first, by transecting only the outer table of the sternum below the manubrium and, leaving the inner table intact, bending the sternum up

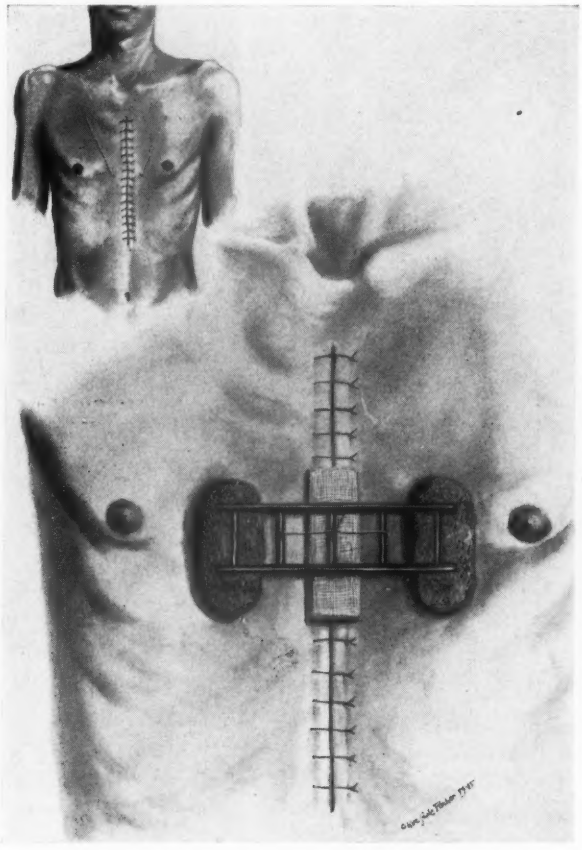

FIG. 7.—The radical operation: The wound is closed and the wires carried out through the skin on each side of the incision (insert) and fastened into the ladder.

into place, making a sort of greenstick fracture. The wire sutures employed by Brown and Sweet have not seemed necessary to us and we have never used them. The second factor in maintaining the stability is the use of a Jacob's ladder. This will hold the sternum in its new position and prevent paradoxic respiration. The ladder must be left on until a certain amount of stability in the chest wall has taken place. Judging by the length of time required to obtain stiffening after thoracoplasty we have left the ladder in place ten days. Three weeks should be ample, and probably unnecessarily long.

In one of our cases the wire broke on the sixth day thus disposing of the ladder in less than a week and nothing untoward developed.

A longitudinal incision is made over the midline of the sternum starting at the level of the second rib and extending down onto the abdomen a third or half the distance between xiphoid and umbilicus. The skin flaps are mobilized to give adequate exposure and the pectoralis major and rectus abdominis muscles separated and retracted from sternum and costal cartilages

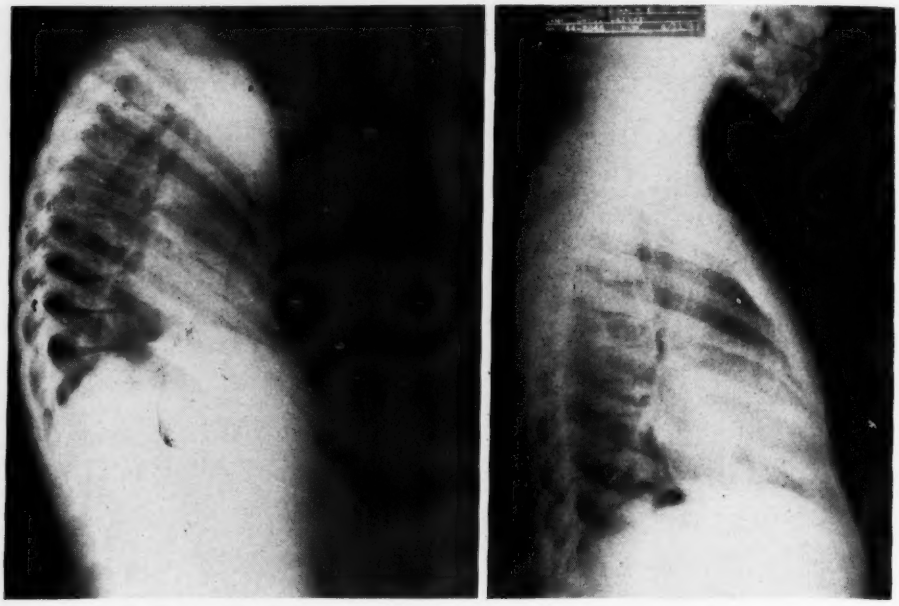

FIG. 8-A FIG. 8-B

FIG. 8.—The effect of the simple operation on the exaggerated dorsal curve of the vertebral column.

(A) Before operation.
(B) After operation.

(Fig. 4). Even with this exposure it is very difficult to identify the xiphoid because the deformity buries it under the cartilages of the costal arch. Subperichondrial resection is then performed on the cartilages from the sternum laterally to the start of the deformity but not taking more than the third. The lower end of the sternum is next grasped in forceps and drawn forward to demonstrate the xiphoid-gladiolus attachment which is cut (Fig. 5). The substernal ligament is severed at the same time. The pull of the diaphragm immediately widens the separation giving access to the ventral mediastinum. Occasionally, in a young individual, the sternum may be elevated into its normal position by fracturing it along the cartilaginous line between the second and third segments. If this proves impossible a transverse wedge of bone is removed from the outer table of the upper part of the third segment,

care being taken not to cut the inner table, and the sternum elevated into its proper position by making a subperiosteal fracture of the bone at this site.

Brown advocates leaving the substernal ligament intact and separating the sternum from it without entering the mediastinum. The substernal ligament is divided later. With our first patients we followed this plan but in one case the substernal ligament was so densely adherent to the periosteum of the under surface of the sternum that heavy, sharp periosteal elevators had to be used in the relatively inaccessible area under the sternum and the pleura was torn. Since then we have divided the substernal ligament with the xiphoid and had no hesitancy in entering the mediastinum. If the substernal ligament is found intact after the sternum has been elevated it must be completely divided. If this is not done the deformity is only partly corrected and is sure to recur.

After the sternum is elevated two drill holes are placed in its lower portion just above the free end and a silver wire threaded through them with the free ends brought out of the wound (Fig. 6). The pectoral and rectus muscles are sutured to each other across the midline of the sternum and the skin wound closed without drainage. Before closing the skin the ends of the silver wire are brought out onto the chest wall through punctures in the skin flaps. The Jacob's ladder is padded and laid across the chest wall where the wire emerges and the wire drawn up and twisted into the ladder (Fig. 7). This elevates the sternum into its proper position and holds it there, thus preventing paradoxic respiration as well. The ladder must be secured firmly with an adhesive dressing. It is removed ten days to three weeks later depending on the stability of the chest wall.

All the wounds healed by primary union but three of them subsequently opened at their lower ends and discharged serous fluid from the dead space left by the elevation of the sternum. The sinuses thus formed were rather slow to heal but pus never developed and there were no bad effects from it. This would seem to indicate that fear of mediastinitis is exaggerated.

Five cases have been treated by surgical operation. All have received relief from their pressure symptoms. With regard to the deformity the result was excellent in one case, satisfactory in three and unsatisfactory in one. There were no deaths.

CASE REPORTS

Case 4.—R. H., a six-year-old girl, was admitted to the Pediatric Service of Bellevue Hospital, December 3, 1943, complaining of fever, cough, running ear and dyspnea on exertion. She had had measles and frequent colds, coughs and running ears. A year ago she had been a patient at Bellevue Hospital, with running ears and upper respiratory infection.

Ever since birth the child had had a funnel chest deformity. In spite of this her infancy had no serious disturbances but during the past few years she has suffered increasingly from dyspnea on exertion and the funnel chest deformity has been deepening. She has been a patient in the cardiac clinic for systolic and diastolic murmurs and cardiac incompetence. This was thought to be due to the funnel chest and on her previous hospital stay operation was advised for this deformity. It was not done because of parental

objections. The cardiac condition is now so bad that she is unable to play with other children or even to run 50 feet. As a result she has become a social problem and is irritable, morose and unresponsive. Her appetite is poor and her development, both physical and mental, is retarded.

Physical examination shows a sullen, resistant child, poorly nourished and sitting in bed in a stoop-shouldered posture. External strabismus of the right eye is present. Both ears have perforated drums with purulent discharge. Moderate enlargement of cervical lymph nodes is noted. Heart displaced to left with apex in midaxillary line. Rate rapid and regular; loud systolic and diastolic murmurs. Lungs not remarkable. Abdomen and extremities not remarkable. Chest is the site of a marked funnel deformity with the xiphoid so deeply depressed that it cannot be felt (Figs. 9 and 11). Laboratory data: R. B. C., 5,070,000; Hb., 15 Gm.; W. B. C., 18,000, 70 per cent polys. Urine: Normal.

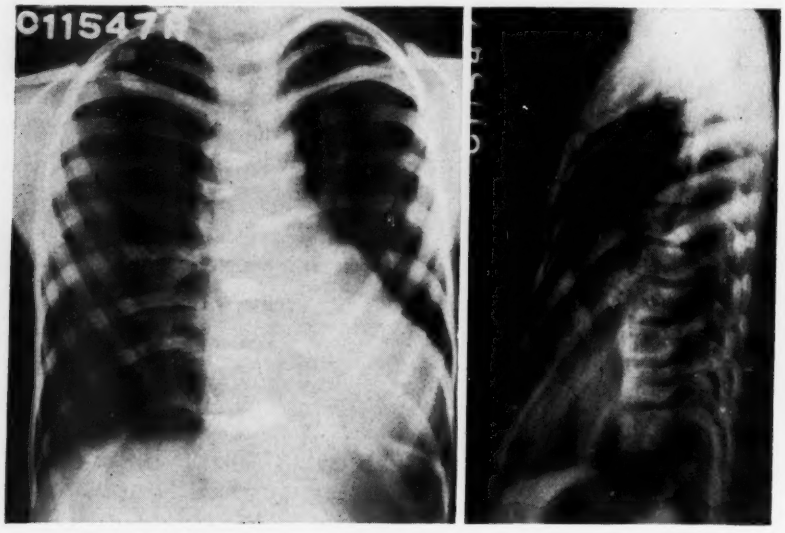

FIG. 9-A FIG. 9-B

FIG. 9.—The irreversible deformity: Postero-anterior and lateral roentgenograms before operation. The apex of the heart is at the axillary chest wall and the xiphoid is only 1 cm. in front of the vertebral column.

With sulfadiazine and general hygienic treatment the ears ceased to discharge and the cough disappeared. Her temperature which was 101° F. on admission dropped to normal on the third hospital day, and her general condition improved steadily. Operation for repair of funnel chest deformity was undertaken three weeks after admission.

A curved incision was made starting over the left second costal cartilage swinging to midline and then back along the left seventh costal cartilage. The sternum was exposed by dissecting back the pectoral and rectus abdominis muscles. The fourth, fifth and fused sixth and seventh costal cartilages were then stripped of their perichondrium for a short distance and about 1.5 cm. of each resected. Access was thus gained to the under surface of the sternum which was separated from the substernal ligament by blunt and sharp dissection. This exposed the junction of xiphoid and gladiolus which was severed. The substernal ligament was then identified and severed, allowing the sternum to come up and the xiphoid to be pulled sharply backward. The sternum was then elevated into place by fracturing it along the junction of its third and fourth segments which had not yet ossified. The resected ends of the fifth left costal cartilage were

approximated by a stainless steel wire which was carried out through the skin and fastened to a Jacob's ladder on the chest wall. The wound was closed without drainage.

Postoperative course was uneventful. The child was placed in an oxygen tent for three days. On the sixth day the wire broke and the ladder was removed. The wound was well healed on the seventh day and the sutures removed (Fig. 10), but the child was kept in bed for three weeks to avoid the dangers inherent in a ward full of children. The general response to the operation was dramatic. The child was no longer sullen and unresponsive. She took an active interest in her surroundings and when allowed out of bed was so active that she had to be restrained. Never having been able to run

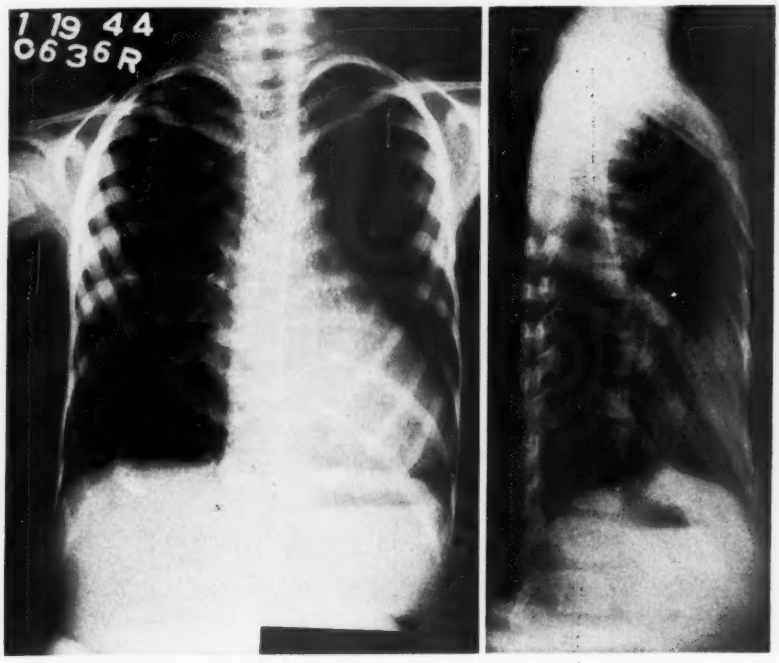

FIG. 10-A FIG. 10-B

FIG. 10.—The irreversible deformity: Postero-anterior and lateral roentgenograms after operation. The sternum has been elevated and the heart has moved away from the axillary chest wall.

before, the novelty of it so appealed to her that she ran all over the place. She was discharged five weeks after operation. Eighteen months after operation she was well, active and leading the normal life of a child of her age. The funnel depression was about 75 per cent corrected, but she was entirely relieved of her symptoms.

Case 5.—G. C., a 13-year-old boy, was admitted to the Hospital for Special Surgery, August 10, 1944, complaining of depressed sternum. His past and family histories had no bearing on the present condition. The deformity of his sternum was noticed at birth and it was becoming deeper. He had had the usual childhood diseases. The deformity limited his action somewhat and he found that he could not keep up with the other boys with whom he played, although when at rest there was no evidence of dyspnea. He is a shy, diffident boy who offers no objections to instructions but consistently fails to carry them out unless he wants to. This is felt to be the result of his deformity. During the preceding six months the distance between xiphoid and vertebral column has decreased by one centimeter.

Operation was performed August 11, 1944. A longitudinal incision was made over the midline of the sternum and flared-out along the costal arch in the shape of an inverted Y. The sternum and costal cartilages were exposed and the lower three costal cartilages on each side were resected. The sternum was divided just above the xiphoid and the substernal ligament separated from the sternum with great difficulty. While using a periosteal elevator beneath the third segment the right pleura was damaged and a pneumothorax established as a result. The sternum was fractured along the junction of the third and fourth segments and the sternum elevated into its normal place. The substernal ligament was then divided and a transverse section one centimeter wide was removed. Attempt was then made to close the tear in the pleura, but without success, so a flap of muscle was raised from the pectoralis major on the right and sutured into the tear. With this in place it was not necessary to fix the sternum because the interposed muscle prevented it from dropping into its original position. The wound was closed without drainage, and all the air possible was aspirated from the right pleural space. The boy was returned to bed and placed in an oxygen tent. Fluid and air were aspirated from the right pleural space on two occasions allowing the lung to reexpand in five days when the oxygen tent was discontinued. Recovery was uneventful thereafter except that the boy was entirely unresponsive to all suggestions regarding posture and exercise to prevent recurrence of the funnel chest. Nevertheless, rontgenograms three weeks after operation showed the sternum in a normal position. Serous drainage developed in the lower end of the wound and persisted for six weeks but eventually ceased and the wound healed. One year after operation he was able to play tennis without undue fatigue or dyspnea but his funnel chest had recurred and the tip of the sternum was only one centimeter farther from the vertebral column than before operation. Functionally the result was satisfactory but physically the deformity was but little improved.

Case 6.—V. M., a 17-year-old white male, was admitted to Bellevue Hospital July 24, 1944. His chief complaint was funnel chest deformity since early infancy and a cough of two weeks duration. There were no other funnel chest deformities in the family. He had pneumonia at the age of two and appendicectomy at the age of 14. Past history was otherwise irrelevant.

He had noticed the deformity in his chest as long as he can remember. He develops some dyspnea on exertion and for that reason he has been unable to do all in the way of physical exercise that his companions do. He thinks this exertional dyspnea has been increasing. He has had a cough for two weeks.

Physical examination shows the patient to be round-shouldered and underweight but otherwise normal in appearance. The chest is the site of a funnel deformity with the xiphoid forming the apex of the depression and lying but three centimeters from the vertebral column (roentgenographic measurements). The sternum and costal cartilages enter into the funnel deformity; the lower ribs flare out and the upper ribs produce a barrel chest laterally (Fig. 12). The manubrium sterni is in its normal position but the sternum curves backward from this point to the xiphoid.

The heart is markedly displaced to the left and shows tachycardia, precordial heave and coarse systolic murmurs in aortic and mitral areas. Lungs show a mild acute respiratory infection at both bases. Fluoroscope shows the diaphragm to move little, if any, during inspiration. Electrocardiogram showed right axis deviation. Lung volumes were 60 per cent of normal and ventilation 70 per cent.

Operation was postponed until August 7th to allow the respiratory infection to subside. Under endotracheal cyclopropane anesthesia, a longitudinal incision was made over the midline of the sternum from manubrium to xiphoid and extended along the costal arch from this point to make an inverted Y. The skin, subcutaneous tissue, pectoral muscles and rectus abdominis muscles were reflected laterally exposing the sternum. Beginning at the fused sixth and seventh the cartilages on both sides were resected subperichondrially for about two centimeters each up to and including the third. The sternum

was drawn up by forceps and the xiphoid severed from the gladiolus. This had little effect on the deformity until the substernal ligament was likewise severed and the diaphragmatic attachments pushed off from the resected costal cartilages for 2 cms. on each side of the xiphoid. The sternum could then be elevated but would not stay in place until a wedge osteotomy was performed across the second sternal segment taking the outer table but leaving the inner intact. A silver wire was then threaded through two drill holes in the lower end of the sternum and the free ends brought out onto the chest wall on either side of the incision. The muscles, subcutaneous tissues, and skin were then closed over the sternum and the ends of the wire twisted into a Jacob's ladder placed across the chest in such a manner as to fix the sternum in its normal position.

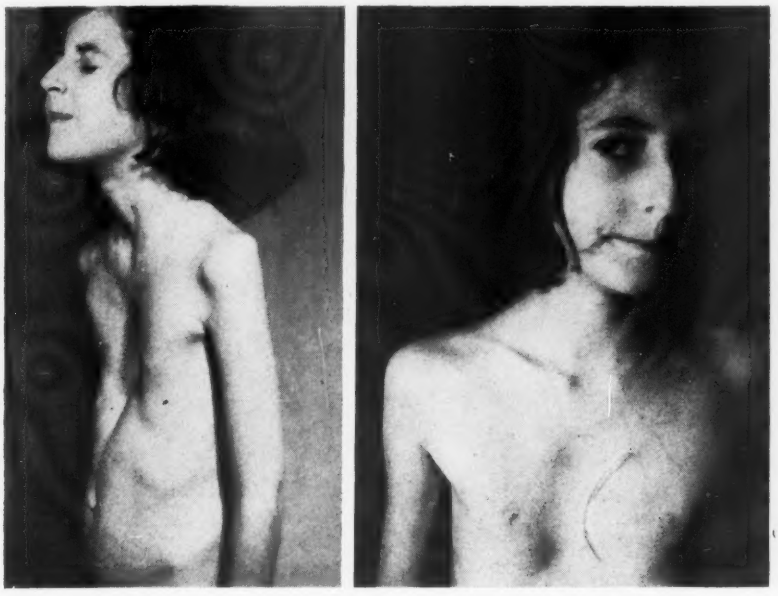

FIG. 11-A FIG. 11-B

FIG. 11.—Photographs of patient R. H., whose roentgenograms are shown in Figure 10 A and B, before and after operation, respectively.

The postoperative course was complicated by the drainage of serous fluid from the lower end of the wound but this ceased after two weeks and the wound healed. The ladder was removed at the end of the third week and the sternum remained elevated in its normal position although there was still a slight depression of the sternum. One year after operation (Fig. 12) the boy is able to play football without distress and has gained weight and strength. He still continues to have his heart murmur. His lung volume has increased to 75 per cent of normal and his maximum breathing capacity in a like proportion. The depression is still present to a slight degree but seems to be lessening.

Case 7.—I. S., a four-year-old boy, of Puerto Rican parents, was admitted to Bellevue Hospital, December 29, 1944, referred by Dr. E. Guilfoil. The chief complaint was increasing funnel chest deformity. His birth history was not unusual. He had pneumonia 18 months ago and bronchitis two weeks ago. His tonsils were enlarged and he had suffered from frequent sore throats. There are two siblings neither of whom has a funnel chest.

At birth the mother noticed no abnormality of the chest but when the child was about a year old a depression appeared over the end of the sternum which has become increasingly deeper. There were no symptoms of cardiac embarrassment.

Physical examination showed a fairly well-nourished Puerto Rican boy of four. Tonsils were enormous and almost met in the midline of the pharynx. His voice was affected by the tonsils but not his breathing. Lungs normal; heart displaced to the left with normal rate and roughened first sound at the apex. EKG was normal. Abdomen showed no abnormalities. The chest presented a marked depression of the lower end of the sternum with flaring of the lower costal cartilages and a well-established funnel chest. The xiphoid was further retracted on inspiration.

FIG. 12-A FIG. 12-B

FIG. 12.—Patient V. M. Irreversible deformity before and after operation.

Operation was performed January 8, 1945. Under ether anesthesia administered through an intratracheal tube, a longitudinal incision was made from manubrium to xiphoid where it was extended to form an inverted Y along the costal arch. The pectoral and rectus abdominis muscles were separated from their sternal attachments and retracted laterally. The seventh, sixth, fifth and fourth costal cartilages were resected on each side and the sternoxiphoid articulation developed. This was transected through into the uncovered space severing the substernal ligament at the same time. Thus released, the xiphoid was retracted back and the sternum was easily elevated into its normal position without the necessity of performing an osteotomy of the sternum. The resected ends of the fifth cartilages were sutured by a single black silk suture on each side and the lower end of the sternum held up by a silver wire looped under the lower end of the sternum and carried out onto the chest wall where the ends were fastened into a Jacob's ladder. The wound was closed without drainage.

The postoperative course was uneventful except for some slight infection around the wire holes. Sutures were removed on the seventh day and the ladder and wire on the ninth. The patient was discharged February 8, 1945, with wound healed.

Five weeks later he was readmitted, with the history of a draining sinus at the lower end of the wound of 19 days duration. A silk suture was removed from the sinus, whereupon it healed promptly. Seven months after operation his tonsils and adenoids were removed. Eleven months after operation the sternum is in a nearly normal position but there is still a slight depression and a slight flare to the lower costal cartilages. The deformity seems to be decreasing as the child grows. His general condition is excellent in all respects.

Case 8.—C. D., a nine-year-old white girl, was admitted to the hospital, July 25, 1945, with the chief complaint of funnel chest deformity. The mother states that the deformity has been present since birth but that it has not increased materially lately. She becomes short of breath on exertion and tires easily. A systolic heart murmur was noted by Dr. Clarence E. de la Chapelle who considered it due to the pressure on the heart by the sternum and referred her for operation.

She is an only child and there is no history of other funnel chest deformities in the family. Her past history is noncontributory.

Examination shows a thin but otherwise healthy child of nine. The sternum shows a marked depression deepest at the xiphoid which is displaced to the right, thus giving an asymmetry to the deformity. The manubrium is in a normal position but from this point the sternum curves backward and to the right carrying with it the costal cartilages which enter into the formation of the funnel as far lateral on each side as the bony ribs. The funnel deepens on inspiration. The heart is displaced into the left chest and has a systolic murmur. The remainder of the physical examination is essentially normal.

Operation was undertaken July 26, 1945. Under intratracheal ether anesthesia, a longitudinal incision was made from manubrium to halfway between umbilicus and xiphoid. The skin, subcutaneous tissues and pectoral and rectus abdominis muscles were reflected laterally. Subperichondrial resection was then done of the fused sixth and seventh, fifth, fourth and third costal cartilages on each side back to the bony rib. The xiphoid was detached from the manubrium and the substernal ligament divided at the same time. The diaphragmatic attachment to the fused sixth and seventh costal cartilages was freed. Even with this amount of liberation it was not possible to elevate the sternum until a transverse wedge osteotomy was performed removing the outer table of the sternum a little above the third rib. The sternum could then be raised into a normal position. Two drill holes were made in the lower end of the sternum and a silver wire threaded through them with the loose ends carried out through the skin on each side of the incision. Nothing else was done to stabilize the sternum. The muscles, subcutaneous tissues and skin were then sutured together and the ends of the silver wire were twisted into a Jacob's ladder placed across the chest. The child was returned to bed and put in an oxygen tent.

The postoperative course was uncomplicated. The oxygen tent was discontinued the second day after operation. The skin sutures were removed on the seventh day and the ladder on the tenth. The patient left the hospital two weeks after operation.

Six weeks after operation the chest wall was solid and the deformity corrected except for a slight flattening of the anterior chest wall. Four months after operation the same good result continues. The murmur is still present but to a much less degree.

COMMENT.—These cases represent the deformity after it has become established. In all cases the substernal ligament and the costal cartilages had to be resected to allow the sternum to come up to a normal position and in all but one it was necessary to fracture the sternum either through the cartilaginous union of the segments or by means of a wedge osteotomy of the sternum in its second segment. Relief of cardiac pressure can be obtained without complete correction of the deformity. To obtain maximum correction of the deformity subperichondrial resection of the cartilages must be performed

back to the bony rib and it may even be necessary to resect part of the bony rib. Stability of the sternum can be obtained by the use of a Jacob's ladder which must be left on until sufficient regeneration of cartilage or bone has occurred to fix it in the normal position. With one exception the late results have been satisfactory.

SUMMARY

Funnel chest is a deformity of the sternum characterized by a funnel-shaped depression of the sternum with the apex at the xiphoid. It is caused by a short central tendon of the diaphragm which pulls the xiphoid backwards during inspiration. It may produce pressure on the heart causing palpitation, dyspnea on exertion (sometimes extreme) and chronic malnutrition and underdevelopment. In infancy, when the deformity is in a reversible stage a simple operation suffices to correct it. Later, when the deformity has become fixed, a much more extensive operation is necessary. Operation results in a high percentage of satisfactory results.

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THE USE OF TESTOSTERONE PROPIONATE IN THE TREATMENT OF ADVANCED CARCINOMA OF THE BREAST

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NUMEROUS INVESTIGATORS, stimulated by the researches of Lacassagne and of Loeb, have demonstrated that the administration of the estrogenic hormones produces mammary carcinoma in mice. An attempt to counteract this carcinogenic effect of estrogens by means of androgens was a logical consequence. That this result could be achieved in animals was early established by several investigators (Raynaud, Lacassagne, Murlin, and his collaborators).

This principle of inhibiting the activity of the gonadal hormones of one sex by the administration of the gonadal hormones of the opposite sex has been employed in recent years in the treatment of human cancer. Encouraging results have been obtained in the treatment of prostatic cancer by the estrogens.

There are, however, surprisingly few reports of the use of androgens in the treatment of human carcinoma. In 1939, publications by Ulrich, and by Loeser, described favorable changes in patients with advanced carcinoma of the breast coincident with the administration of testosterone propionate. The latter author, in 1941, reported additional cases which appeared to be favorably influenced by this therapy. In a recent publication, Fels obtained gratifying results in one of three patients treated with testosterone propionate.

Farrow and Woodard (1942), on the other hand, using small doses of testosterone propionate concluded that in certain instances osseous metastases from breast carcinoma were stimulated by this agent.

We have investigated the effects of large doses of testosterone propionate on advanced carcinoma of the female breast. Eleven patients received this treatment, four of whom have to date exhibited a favorable response. The abstracts of these four case histories follow:

CASE REPORTS

Case 1.—S. K., a 63-year-old married white woman, 13 years postmenopause, was admitted to the Clinic on January 30, 1945. She had noticed a mass in the right breast near the nipple in August, 1939. She was a Christian Scientist and, therefore, paid no attention to the mass until about four years later, at which time it had become very large. This, however, gave her no great concern but a mass in the right side of her neck, which had been increasing in size for four months, alarmed her. She feared it might strangle her, and for that reason she sought medical attention.

The physical findings on February 1, 1945, were as follows (Fig. 1). The right breast was elevated, nipple retracted and stuck flush with the areola margin. The breast was completely replaced by a hard, nodular mass but was still somewhat movable on the chest wall. The skin overlying the mass was pinkish in color and there was pigskin appearance most marked on the medial and lower aspects of the breast extend-

ing over to the sternum. There was an area of redness and impending ulceration just medial to the areola border and there was a similar area on the inferior aspect of the breast. The left breast was negative. There were numerous skin nodules, some 0.5 cm. in diameter, extending on to the abdominal wall. There were several similar nodules

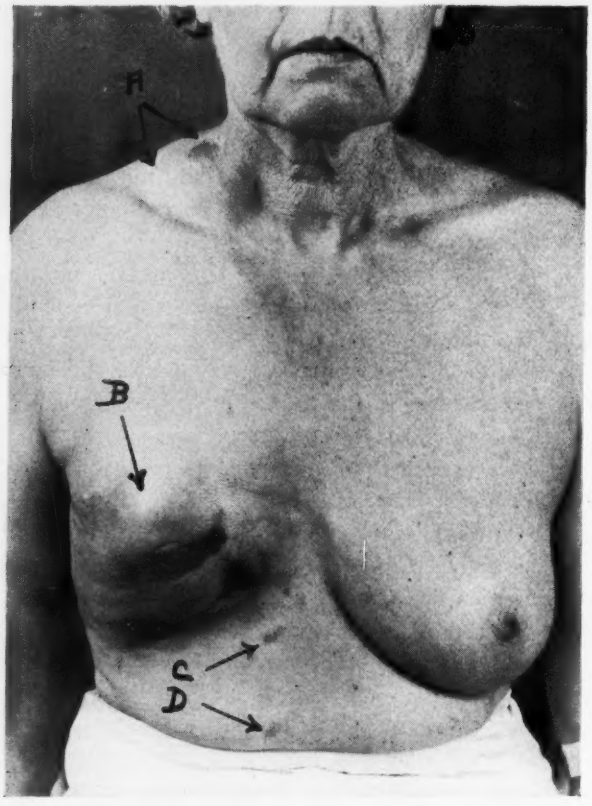

FIG. 1.—Case 1: Photograph shows the lesions before instituting testosterone propionate therapy. A group of enlarged nodes may be seen in the right supraclavicular area (A). The right breast is completely filled with a large mass whose nodules are discernible; one large protruding mass is seen just above the areola (B). Below the areola there is an extensive area with pigskin appearance and dimpling. Medial to the areola is an area of impending ulceration. Below this is a similar larger area in which ulceration is imminent. Medial to these areas and extending almost to the opposite breast is another area of *peau d'orange* appearance. Two nodules, one higher than the other, may be seen in the skin of the right upper abdomen near the midline (C and D).

in the skin overlying the right scapula. The right supraclavicular space was filled with a hard, fixed, nodular mass with several hard nodules in the right postcervical chain extending to the level of the mastoid process. There were numerous nodules in the skin of the right neck. There were several hard, shotty nodules in the left supraclavicular space. Numerous large hard nodes were palpable in the right axilla.

Biopsy of the breast was reported as infiltrating duct carcinoma and an excised

skin nodule revealed mammary carcinoma involving the lymphatics. Roentgenograms of the chest, lumbar spine and pelvis were negative for metastases.

Therapy.—On March 2, 1945, 300 milligrams of testosterone propionate in pellets were implanted subcutaneously. From March 5 to March 24, 1945, 2,600 milligrams of testosterone propionate were administered intramuscularly in 200 milligram doses.

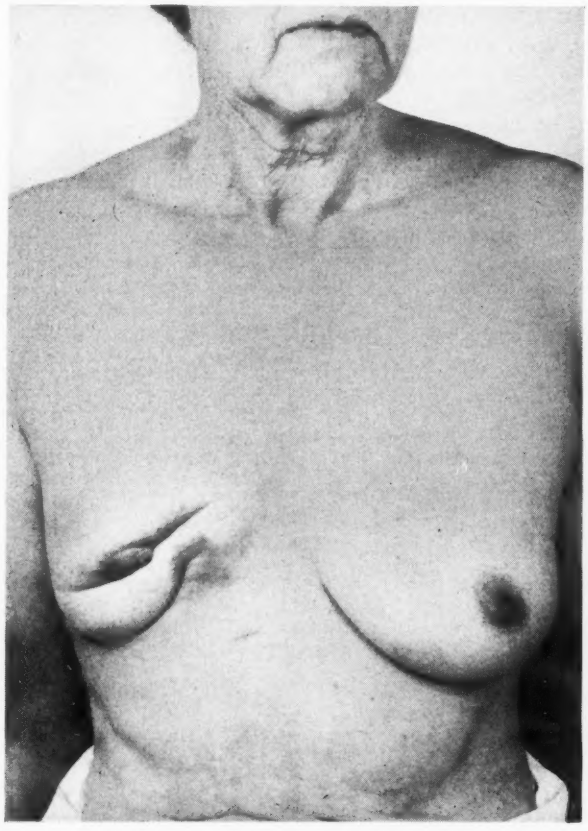

FIG. 2.—Case 1: This photograph was taken about 3.5 months after the preceding one. Within this period the patient had received 3,975 milligrams of testosterone propionate. The right supraclavicular nodes are no longer present. No nodules can be seen in the breast. The protuberant mass above the areola is no longer present. Likewise, the areas of impending ulceration and of pigskin appearance have entirely disappeared leaving the skin of the breast smooth. The upper skin nodule in the abdominal wall was removed for examination. The scar of the excision may be seen. The lower nodule has completely disappeared.

Over an interval extending from March 24 to June 6, 1945, 25 milligrams of testosterone propionate were injected intramuscularly three times a week. The total dose administered up to June 6, 1945 was 3,975 milligrams.

Progress.—Examination on April 17, 1945, about one month after instituting the therapy, revealed the right supraclavicular mass to be very much smaller. Nodes were no longer palpable in the right postcervical chain. The skin nodules in the neck and

in the scapula region were no longer present. Only one minute, soft node was palpable in the right axilla.

Examination on April 14, 1945, revealed the right breast to be soft and freely movable on the chest wall. The areas of redness on the medial and inferior aspects of the breast were markedly diminished in extent and the masses underlying these areas were much smaller and softer. No supraclavicular or axillary nodes were palpable.

On May 12, 1945, some increase in facial hair was noted and, on May 19, 1945, two skin nodules which had persisted in the right upper anterior abdominal wall were no longer discernible.

The physical findings on May 26, 1945, were as follows: There was a slight pink coloration of the medial aspect of the right breast with slight induration underlying it. No masses were palpable in the breasts. The areas of impending ulceration in the right breast were no longer present. No lymph nodes were palpable in the cervical, supraclavicular or axillary regions. No skin nodules were present (Fig. 2).

Roentgenograms of the chest, lumbar spine and pelvis made at this time were negative for evidence of metastatic disease.

LABORATORY DATA

	2/1/45	2/13/45	2/15/45	3/9/45	3/31/45	4/21/45	6/2/45
Blood:							
Hb	84		70		79	82	78
R. B. C.	4	3.5	3.5		3.9	3.9	3.8
W. B. C.	6.5				6.7	5	8
Polys.	77				84	77	88
Lymphs.	22				15	23	
Monos.	1				1		12
Hematocrit		34%	32%			32%	
Alkaline phosphatase	1.6			2.1			2.4
Serum phosphorus	3.5			2.7			3.78
Serum calcium	11.1			10			10.6
Urine:							
Sp. gr.		1.005					1.010
Albumin		0					0
Sugar		0					0
Micro		0					0
Body weight (lbs.)	126			130		135.5	131.5

The gain in weight of 9.5 lbs. in 11 weeks coincided with the disappearance of the lesions. The subsequent weight loss was due to a throat infection which interfered with swallowing.

Case 2.—A. S., a married white woman, age 47, underwent a radical mastectomy for a Grade 3 infiltrating duct carcinoma of the left breast in 1935. The lymph nodes were not involved. In 1937, she underwent roentgen castration as a prophylactic measure. The patient was asymptomatic, and apparently free of disease until January, 1945. At that time she complained of pain in the lower back radiating down both thighs to the legs. Roentgenologic studies of the lumbar spine and pelvis failed to reveal metastases. The pain continued to increase. Roentgenograms taken 2.5 months later (April 9, 1945) revealed extensive metastases to the lumbar spine and pelvis. The chest was negative for metastases. Physical examination revealed no other evidence of disease.

Therapy.—From April 14, to June 28, 1945, she received a weekly intramuscular injection of 200 milligrams of testosterone propionate, for a total dose of 2,400 milligrams.

Progress.—When she began treatment she was unable to walk without aid and could not sleep because of pain in the lumbar spine and hips. Some relief was obtained from large doses of codeine. The pain gradually subsided and, on May 19, 1945, she was asymptomatic.

On June 1, 1945, roentgenograms were again taken of the lumbar spine and pelvis. Compared with those taken in April, 1945, a slight increase in density in the areas of metastases was noted.

Roentgenologic studies made on June 21, 1945, revealed a further increase in the density in the bones involved by the metastases, indicating still further osteoblastic change since the earlier films were made. These changes may be seen by a comparison of Figures 3 and 4. The patient has remained asymptomatic to date. Aside from the regressing process in the lumbar spine and pelvis there is no evidence of disease.

LABORATORY DATA

	4/9/45	4/28/45	5/10/45	6/7/45
Blood:				
Hb		56		60
R. B. C.		2.7		2.9
W. B. C.		9.3		5
Polys.		58		60
Monos.		5		
Lymphs.		37		40
Serum calcium	11		10	10
Alkaline phosphatase	5.5		21.5	25.2
Serum phosphorus	4.07		2.52	2.86
Body weight (lbs.)	122.5		131.5	137

The gain in weight of almost 15 lbs., and the great increase in the serum alkaline phosphatase are noteworthy.

Case 3.—S. K., a 42-year-old single white woman, menstruating regularly, consulted the Clinic December 6, 1944. She became aware of a painless mass in the left breast one year previously but failed to seek medical advice. About two months prior to admission the breast began to pain, and she noticed that the skin over it was dimpled, the nipple retracted and that it was now smaller than the opposite breast. One month later she began to experience pain in the left lumbar region which extended to the buttock and radiated down the posterior aspect of the left thigh. Because of this pain it was difficult for her to walk or change position when sitting or lying, and for this reason she came to the Clinic.

Examination revealed an elevation and deformity of the left breast with retraction of the nipple and areola. There was pronounced dimpling involving most of the breast integument. In the subareola region, extending outward on the 5 o'clock radius was a poorly-outlined mass measuring 2 x 3 cm. There were several small firm nodes palpable in the left axilla. There was no supraclavicular adenopathy.

Aspiration biopsy of the breast mass was reported as carcinoma. Roentgenograms of the lungs were negative but those of the lumbar spine and pelvis revealed numerous areas of bone destruction which were interpreted as carcinoma metastases. The patient failed to return to the Clinic after this preliminary investigation, and it was subsequently learned that she suffered a psychic disturbance which necessitated her being hospitalized.

Three months later, March 1945, she returned. During her stay in the mental institution she received 1,300 r to the left breast. There was no other therapy to the primary site and none to the metastatic lesions. Physical findings were essentially the same as at the previous examination. However, in addition to the pain in the lumbar region which made walking difficult, she now complained of pain in the cervical spine and in the left shoulder.

Roentgenograms, made March 20, 1945, revealed metastases to the bodies of the cervical vertebrae, to the outer third of the left clavicle, to the neck and glenoid of the left scapula and to the head of the left humerus. There were widespread metastases to the lumbar spine and pelvis (Figs. 5 and 6).

Therapy.—On March 10, 1945, 300 milligrams of testosterone propionate in pellets were implanted subcutaneously. From March 12 to March 31, 1945, she received 2,400 milligrams of testosterone propionate intramuscularly in doses of 200 milligrams. From March 31 to June 21, 1945, she received 1,400 milligrams of testosterone propionate intramuscularly in 25 milligram doses. The total dose administered was 4,100 milligrams.

Course.—On April 7, 1945, the pain in the right hip was diminished. Examination of the left breast on April 28, revealed it to be less deformed and the mass smaller and softer. On May 19, 1945, she complained of pain in the upper right ribs in the axillary region, and roentgenologic studies disclosed evidence of extensive metastases to the right ribs. On May 26, 1945, she reported amenorrhea for the preceding two

FIG. 3 FIG. 4

FIG. 3.—Case 2: All of the lumbar vertebrae are involved by metastases. Note the lack of density in the bodies and transverse processes.

FIG. 4.—Case 2: The increased density of the bodies and transverse processes of the vertebrae due to a deposition of calcium is readily appreciated by comparison with the preceding figure. There was an interval of three months between this and the preceding roentgenogram during which time the patient received 2,400 milligrams of testosterone propionate.

months. There was marked facial hirsutism. June 9, 1945, she stated that she had had no pain in the cervical spine for the past month. Pain in lumbar spine and hips was less. Roentgenologic studies were reported as follows: "A comparison of the films of the cervical spine made June 5, 1945, with those made on March 20, 1945, shows a marked change in the appearance of the metastases. There is now a diffuse increase in density in the bodies of the lower cervical vertebrae and in some areas of the remaining vertebrae. This change is also present in the laminae and transverse processes as well as in the upper ribs visualized" (Fig. 7).

"A comparison of films of the lumbar spine, pelvis and left shoulder girdle made June 12, 1945, with those made March 20, 1945, reveals a striking change in the appearance of the metastases in all areas. There is the same diffuse increase in density as was noted in the cervical spine" (Fig. 8).

June 21, 1945: The patient feels well and has no pain. The mass in the left breast and the left axillary nodes are still palpable.

LABORATORY DATA

	12/6/44	3/8/45	3/23/45	3/31/45	4/20/45	5/29/45	6/5/45
Blood:							
Hb	87	62		65			73
R. B. C.	4.6	3		3.2			3.4
W. B C.	12.2			8.4			9.2
Polys.	58			46			42
Monos.	3			2			4
Lymphs.	38			49			48
Hematocrit		21%			18%		
Serum calcium	11.7		12.5		11.4	10.7	
Alkaline phosphatase	3.9		4.9		9.3	9.4	
Serum phosphorus	3.10		3.79		2.92	3.02	
Urine:							
Sp. gr.		1.013					1.008
Albumin	0	0					0
Sugar	0	0					0
Micro.	0	0					0
Body weight (lbs.)		120		124	126.5	128	130

FIG. 5.—Case 3: Shows metastatic disease involving all of the cervical vertebrae with collapse of the 6th.

The gain in weight (10 lbs.) and the increase in serum alkaline phosphatase are the significant changes.

Case 4.—D. F., a 44-year-old white woman, menstruating regularly, consulted the Clinic in October, 1944, because of a mass in the right breast of one year's duration. A diagnosis of carcinoma was made and a radical mastectomy performed. Pathologic examination revealed an infiltrating duct carcinoma Grade 3; axillary lymph nodes clear. She received a cycle of postoperative roentgenotherapy to the right axilla through three ports. She was asymptomatic and apparently free of disease until March, 1945. At this time, she complained of pain in the lower part of her back radiating down the left thigh posteriorly. The pain was so severe that she could not sleep. Large doses

FIG. 6.—Case 3: There is extensive metastatic involvement of the lumbar spine, pelvis and femora.

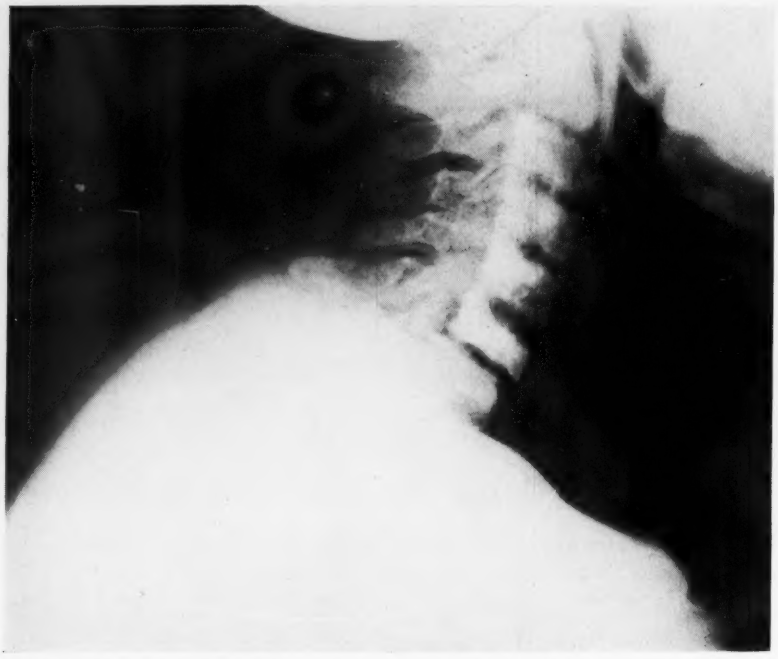

FIG. 7.—Case 3: This is a roentgenogram taken about 3.5 months later. The increased density of the vertebral bodies due to the deposition of calcium is striking. During the interval between the first and second roentgenograms the patient received 4,100 milligrams of testosterone propionate.

of codeine did not control it. Roentgenograms revealed evidence of a large area of destruction in the left ala of the sacrum (Fig. 9). She was given testosterone propionate, 200 milligrams daily, for one week, and 25 milligrams three times a week for ten weeks. The total dose administered was 2,150 milligrams.

Course.—At the end of the first week of treatment the pain was less and she was able to sleep, something she had been unable to do for three weeks preceding the treatment. The pain gradually subsided until at the end of the eighth week she was entirely free of pain. Roentgenologic studies during this period disclosed a progressive regenera-

FIG. 8.—Case 3: An increase in calcification after testosterone similar to that revealed in the cervical spine is seen by comparing this roentgenogram with the preceding one. Arrows call attention to a few of the more prominent metastatic areas which have decreased in size or disappeared altogether. There is pronounced calcification of the lumbar vertebrae and alae of the sacrum.

tion of bone in the area of destruction in the left ala of the sacrum (Fig. 10). At the end of June, three months after the initiation of testosterone therapy the patient resumed her work as a comptometer operator. She was asymptomatic at this time and, aside from the calcifying lesion in the ala of the sacrum, there was no evidence of disease. The therapy produced an amenorrhea and some facial hirsutism.

There was some gain in weight but no significant change in serum alkaline phosphatase.

COMMENT.—In a number of the patients under investigation the expected masculinizing effects of testosterone; namely, hirsutism and deepening of the voice, were encountered. Amenorrhea was produced in those women in whom menstruation had been present before instituting the therapy. An increase in libido, as noted by Shorr and coworkers and Abel, was found in some instances.

Large doses of testosterone produced no discernible effect on the blood picture or renal function as judged by routine examination of the urine. All of the patients who improved under testosterone therapy exhibited an increase

in weight. This may have resulted from the nitrogen retention which is produced by the testosterone. On the other hand, the relief from pain and the consequent ability to sleep may have been contributory factors in the weight gain.

Changes in the serum content of alkaline phosphatase were manifest in two of the three patients described above with bone metastases (Cases 2 and 3). Alkaline phosphatase is produced by bones which are attempting to repair damage from metastases or other causes, and its serum level may, therefore, be used as an index of bone regeneration. It is not clear why the third case, despite marked osteoblastic changes, failed to reveal the expected serum phos-

LABORATORY DATA

	10/11/44	3/22/45	4/19/45	5/29/45
Blood:				
Hb	82		80	71
R. B. C.	3.9		4	4
W. B. C.	7.2		9.2	10.6
Polys.	58		71	80
Monos.	1		2	
Lymphs.	41		27	20
Serum calcium		11.7	11.4	12
Serum phosphorus		3.6	3.78	3.64
Alkaline phosphatase		2.5	2.9	3.1
Urine:				
Sp. gr.	1.018			1.020
Albumin	0			0
Sugar	0			0
Micro.	0			0
Body weight (lbs.)	159	163	161.5	163 1/8

phatase increase. The serum calcium and phosphorus remained within normal limits in all cases. A rise might have indicated an increase in the osteolytic process.

Of the seven patients who failed to show improvement with testosterone therapy two are dead. One had pulmonary and the other liver metastases. Another, who was in a very advanced stage when testosterone therapy was instituted has been unable to continue because she lives in a distant city. A fourth patient had generalized osseous metastases and a serum calcium of 15.5 milligrams per cent when first seen. She received 1,000 milligrams of testosterone propionate within a period of five days. This produced a further increase in the serum calcium associated with nausea, vomiting and depression. The clinical picture was similar to that described by Farrow and Woodard in patients with osseous metastases who had received small amounts of testosterone propionate. Cessation of testosterone therapy produced a drop in the serum calcium and a disappearance of the toxic manifestations. After a lapse of time, during which the serum calcium remained stabilized at about 14 milligrams per cent, testosterone propionate was again cautiously administered. The calcium level once more began to rise and the patient again became nauseated, therefore, this therapy was discontinued. Roentgenologic studies revealed progressive changes in the bone lesions. It would appear that testosterone is contraindicated in patients with hypercalcemia associated with osseous

FIG. 9.—Case 4: A large area of metastatic disease involving the left ala of the sacrum is seen.

FIG. 10.—Case 4: This roentgenogram was taken three months after the one shown in the preceding figure. In the interim the patient had received 2,150 milligrams of testosterone propionate. The increased density in the involved ala is well-defined.

metastases. The importance of routine blood chemical studies in patients receiving testosterone therapy is obvious.

The three remaining patients are still under treatment. All have widespread soft-part metastases but no osseous involvement. Although these patients have not as yet exhibited clinical regression it is too soon to predict the ultimate outcome. It is of interest that biopsies of skin nodules in two of these cases have shown cellular changes. These cellular alterations are described by Dr. Fred Stewart as follows: Of the nodule in one case he says: "Mammary carcinoma. Rather marked focal hydropic degeneration. Mitoses still present." His description of the nodule from the other case is: "Mammary carcinoma. Cells definitely hydropic and nuclei pycnotic. Rare mitoses still seen. The tumor does show distinct differences from the expected."

It is of interest that similar hydropic changes in the cells of prostatic carcinoma have been observed after the administration of estrogens (Shenken, Burns and Kahle).

SUMMARY AND CONCLUSIONS

1. Eleven cases of advanced breast cancer, treated with large amounts of testosterone propionate, are reported.

2. No toxic effects were noted in individuals with normal serum calcium levels, each of whom received several thousand milligrams of testosterone propionate over a period of three months.

3. Four patients, one with soft-part and three with osseous metastases manifested remarkable improvement.

4. The evidence of improvement was the regression of the primary lesion and soft part metastases in one case and an increase in calcification in areas of osseous metastasis in three cases.

5. Disappearance of pain coincided with the osteoblastic changes.

6. In two of the cases that exhibited deposition of calcium in the bone metastases there was a coincident elevation of the serum alkaline phosphatase.

7. Four patients did not respond to the therapy and three others are still under treatment, without clinical evidence of improvement. Metastatic nodules from two of the latter group, on microscopic study, revealed hydropic changes.

8. One patient with an initial hypercalcemia associated with osseous metastases manifested a further rise in serum calcium associated with toxic manifestations in consequence of testosterone therapy. This emphasizes the importance of blood chemical studies in patients receiving this treatment.

9. We believe that testosterone propionate in large doses may, in certain instances, exert a favorable influence on advanced carcinoma of the female breast.

10. The number of cases studied is too small to gauge the frequency of this favorable reaction. From our limited experience the beneficial effects are unpredictable and uncertain. Likewise, the duration of the favorable response and the amount of testosterone propionate necessary to maintain this improved status is as yet unknown.

The authors wish to thank Dr. Helen Q. Woodard of the Department of Chemistry, Memorial Hospital, for making the blood chemical studies embodied in this report. We also are indebted to the Schering Corporation of Bloomfield, N. J., for furnishing us with the testosterone propionate (Oreton) used in this investigation.

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COINCIDENT REMOVAL OF ADDITIONAL STRUCTURES IN RESECTIONS FOR CARCINOMA OF THE COLON AND RECTUM

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DURING RECENT YEARS a rising operability has been reported in carcinoma of the colon and rectum. There is little, if any, indication that this is the result of earlier diagnosis.[5] Rather, it appears to be due to augmented attempts at the removal of growths which previously were considered inoperable. Impulse for such increasing radicalism has been provided by a better understanding of the prevention and control of the several major complications which have attended these operations, primarily shock, infection, and embolism, and by developments in the field of anesthesia particularly the employment of the continuous principle in spinal anesthesia.[3]

Consequently, it is now not unusual for resections of the large bowel to be carried out with palliative intent alone or occasionally to be supplemented by subsequent removal of solitary or grossly localized hepatic metastases.[2, 6] More important, however, has been a trend[1] toward the removal of additional structures or organs adjacent to the primary tumor which are known or considered to be secondarily involved by it in an attempt at cure. A group of such cases forms the basis of the present report.

During the past few years 220 patients with colonic or rectal carcinomas have been seen at this hospital which accepts only indigent patients largely from rural areas.[4] Some idea of the relatively poorer condition of these patients on applying for treatment is evident, in that 86 per cent had lost weight and 67 per cent of these had lost more than 15 pounds. The average duration of symptoms was 18 months. Swinton, reporting from a private urban clinic, found that less than two-thirds of his cases had lost weight and fewer than 50 per cent of these had lost more than 15 pounds. The average duration of symptoms among his patients was nine months.

Specific treatment was not attempted in 31 of the 220 patients, 42 were explored with or without the formation of a colostomy, and resection was carried out in 147 cases, a resectability rate of 78 per cent of all those in whom exploration was considered to be justified, or 67 per cent of all patients seen. Of the first group in which no specific treatment was carried out three patients were resectable but refused operation, four presented extensive postsurgical recurrences, and five were admitted *in extremis* and died before supportive measures could become effective. Eighteen presented clinically obvious distant metastases. A single patient developed a coronary thrombosis while in the hospital and was refused operation on that basis.

Among the 42 patients explored distant intra-abdominal metastases were

found in 35, a large postsurgical recurrence was found in the pelvis of one, and six presented the combination of far-advanced local disease with marked general debility and were felt to be unsafe for anything but colostomy.

Of the 147 resections, 15 (10 per cent) were operated upon with palliative intent alone, and will, therefore, have no further part in the discussion. One hundred and thirty-two resections (90 per cent) were undertaken with hope of cure. Of these, 13 (10 per cent) were accomplished on patients previously explored at other hospitals, where they had been judged unsuitable for resec-

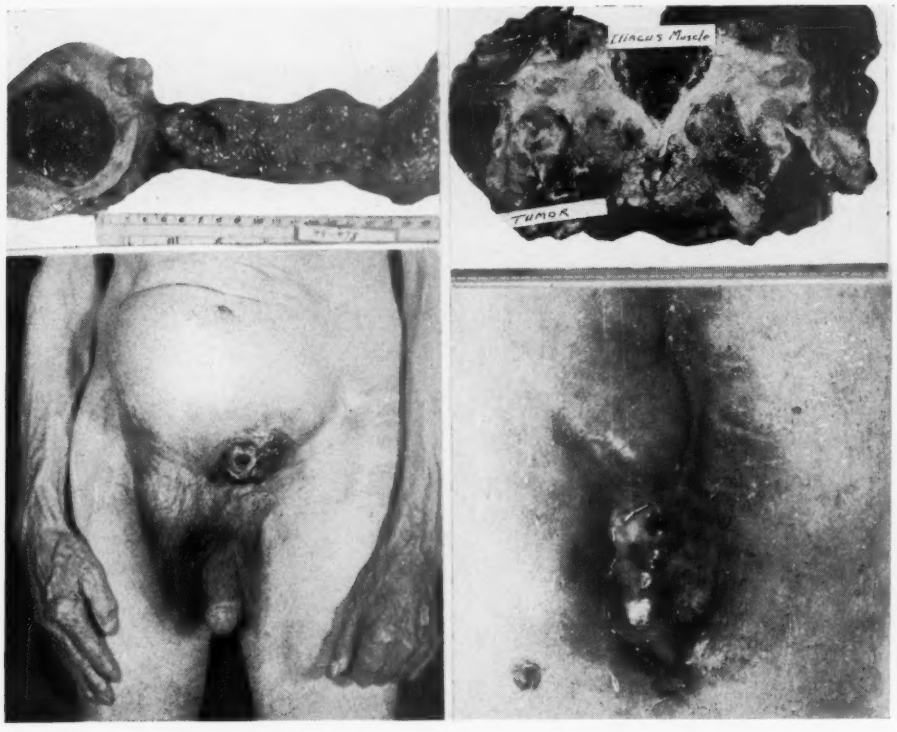

FIG. 1-A FIG. 1-B

FIG. 1.—Abdominal wall involvement by carcinoma of the colon.
A. (Case 6192): Carcinoma of the sigmoid treated two years previously (elsewhere) by Mikulicz resection—recurrent in the implanted bowel and invading the abdominal wall. Treated by Miles' resection in order to accomplish high inferior mesenteric node removal.
B. (Case 4921): Carcinoma of cecum fungating through abdominal wall postappendicectomy, densely adherent to iliacus muscle, removed with abdominal wall, femoral nerve (upper left corner) and iliacus muscle. Abdominal wall following closure consisted of skin lined by omentum.

tion. Excepting for the single above mentioned case with coronary thrombosis no patient was refused operation because of age (10 per cent over 75 years old), diabetes, heart or kidney disease, or general debility, nor was local advancement of the disease by itself a deterrent in any instance. With such a setting it becomes apparent that serious consideration has been given to offering each patient in whom it was not already precluded an opportunity for cure.

In adhering to this principle the removal of some other structure in addition to the bowel was considered necessary in 42 (32 per cent) of the patients

FIG. 2.—(Case 7298): Involvement of the retro-urethral portion of the prostate by an adjacent carcinoma of the lower rectal ampulla. Photomicrograph shows invasion of the prostate.

resected whose disease, though locally advanced, gave no clinical evidence of having spread beyond the limits of possible surgical removal.

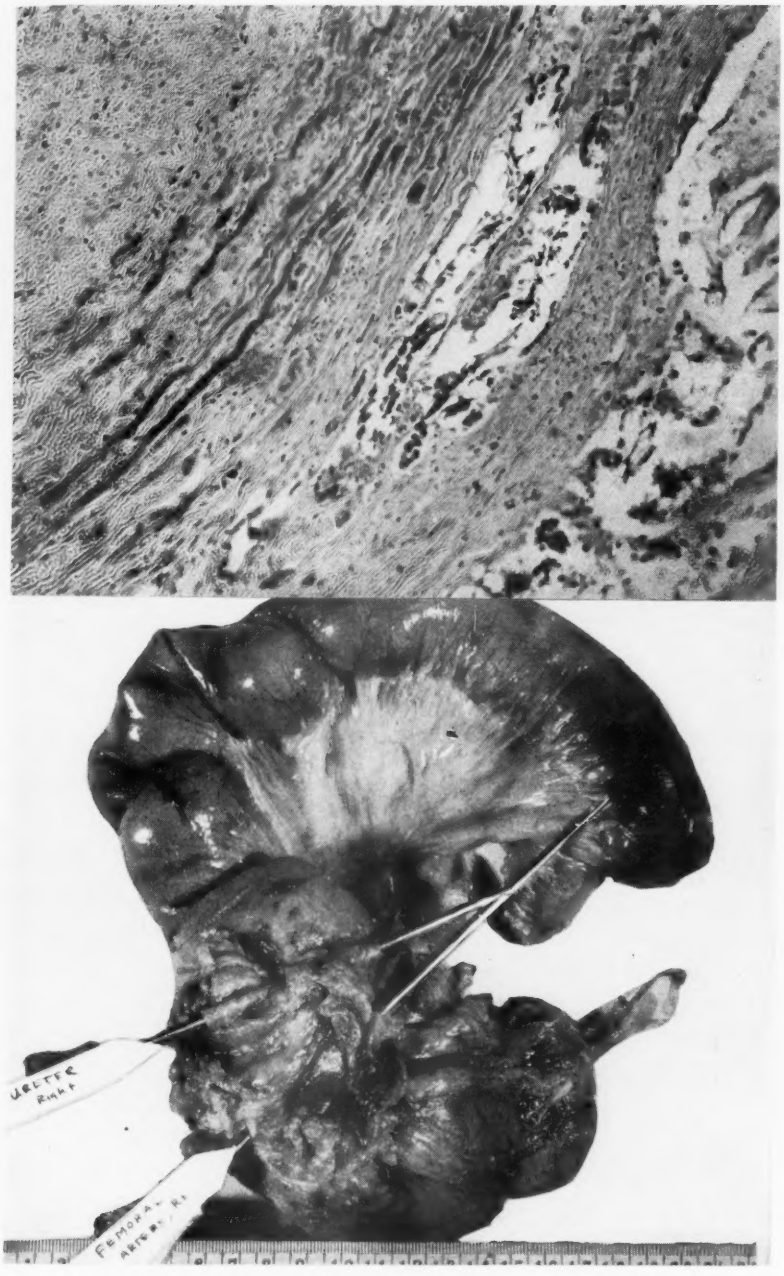

FIG. 3.—(Case 7223): Removal of an adherent loop of ileum, and encircled segment of ureter, and similarly encircled segments of the external iliac vessels by a carcinoma of the rectosigmoid. Photomicrograph shows involvement of the wall of the external iliac artery.

The single indication for extending the resection in all cases was either known involvement of the structure adjacent to the bowel or such firm fixation to it that dissection between them was felt to entail too great a risk of entering disease. Under certain circumstances wide removal about a point of fixation will not be possible; for example, when invasion has taken place deeply into the lateral pelvic wall. All or part of a single structure was removed in 27 patients, of more than a single structure in 15 patients.

Though the average age of the more radically treated patients was somewhat less than that of those receiving resection of the bowel only, 56 and 61 years, respectively, the much higher incidence of weight loss among the former group, 93 and 68 per cent, respectively, would offer some index as to their

TABLE I

CLINICAL AND PATHOLOGIC COMPARISON OF PATIENTS HAVING RESECTIONS OF THE COLON OR RECTUM ALONE AND THOSE IN WHOM THE RESECTION WAS ATTENDED BY REMOVAL OF ADDITIONAL STRUCTURES

	Clinical			Pathologic*					
	Age	Duration Symptoms	Per Cent with Weight Loss	Operative Mortality	Involvement to Serosa	Lymphatic Involvement	Node Involvement (Clearing Method not Used)	Nerve involvement	Vein Invasion
Resection of colon and rectum alone (74 pts.).....	61 yrs.	13 mos.	68%	9%	79%	31%	22%	5%	18%
Resection of colon and rectum attended by removal of an additional structure.....	56 yrs.	15 mos.	93%	19%	95%†	51%	31%	12%	34%

* Note: In 41% the sole ominous pathologic feature was involvement of all layers of the bowel.

† In 50% of cases there was actual extension of disease into the additional structure removed.

generally poorer condition and is in part responsible for an operative mortality of 19 per cent as compared to a mortality of 9 per cent where additional procedure was not thought to be necessary. An almost identical duration of symptoms of 15 and 13 months, respectively, in the two groups of patients would indicate that a more aggressive form of disease is the probable basis for the more radical treatment required.

This is borne out in a comparison of those pathologic findings well-known to adversely influence the prognosis in colonic and rectal cancer; namely, involvement of all layers of the bowel, invasion of neighboring lymphatics, vein invasion, nerve involvement and lymph node metastases. All of these were present in higher percentage in those cases where it was necessary to resect some other structure. It should be noted, however, that in 41 per cent no lymphatic or vein invasion, lymph node or nerve involvement was present, the sole ominous feature being involvement of all layers of the bowel wall (Table I). Furthermore, the same could be said of 9 out of 20 cases in which actual gross or microscopically demonstrable invasion of the adjacent structures had already taken place.

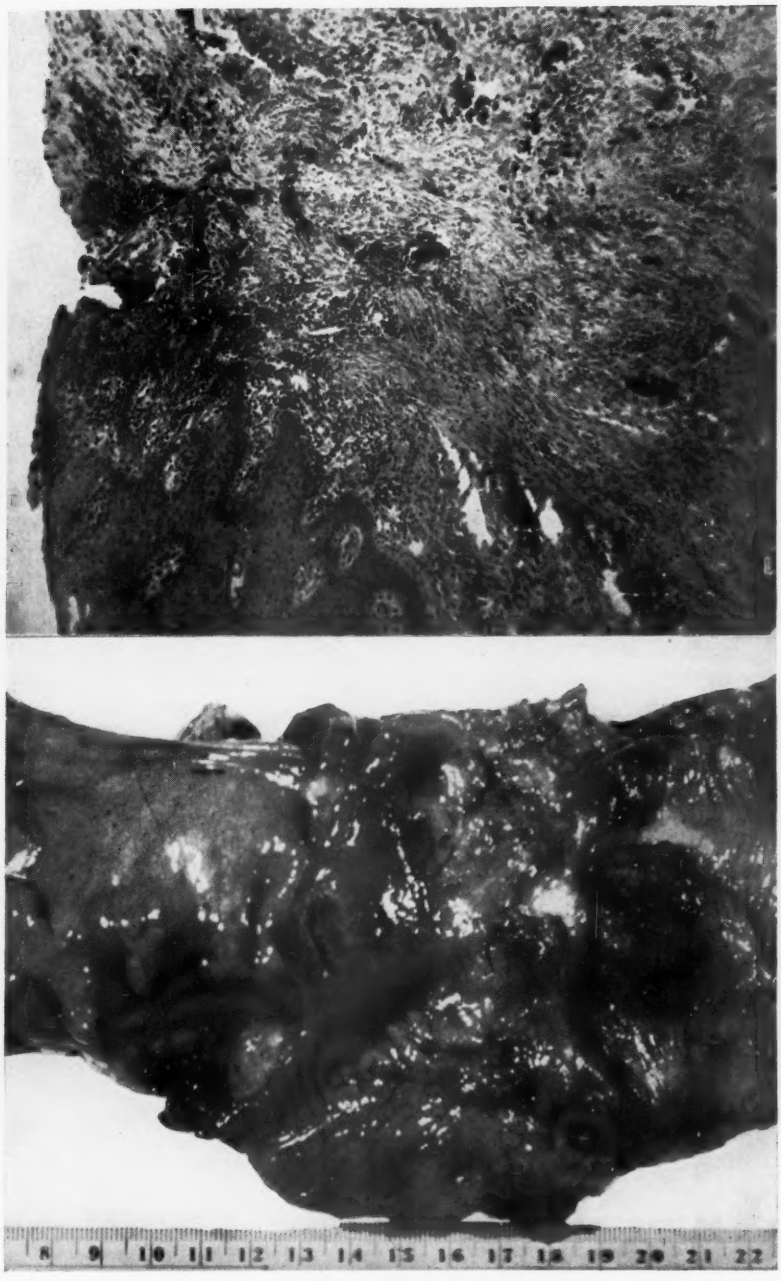

FIG. 4.—(Case 6686) : Uterus, tubes, ovaries and entire vagina removed with rectum for an extensive lesion of the latter—shown fungating through the posterior vaginal wall. Photomicrograph indicates the rectal carcinoma ulcerating through the stratified squamous epithelium of the vagina.

Actual involvement of the additional organs removed was demonstrated in 50 per cent of the specimens. It is highly probable that microscopic invasion would have been noted more often if multiple sections had been taken about the point of fixation where a single section failed to demonstrate it. Since involvement of all layers of the bowel was present in all but two cases it is very likely that dissection carried through the usual tissue planes would have resulted in local recurrence in a high percentage of instances in which microscopic involvement of the adjacent structure could not definitely be demonstrated. In only the above mentioned two cases was the fixation on a strictly inflammatory basis. This would strongly suggest that anti-inflammatory roentgenotherapy when administered as a preoperative measure in badly infected lesions should not change the originally indicated extent of procedure even though the amount of fixation might be appreciably lessened.

Among the various structures removed were included a portion or all of the female genital tract in 23 instances, a portion of the male genital tract (prostate and seminal vesicles) in 8, a portion of the bladder or ureter in 5, a segment of small bowel in 4, a sizable portion of the abdominal parietes in 5, a segment of femoral nerve in 1, and the common iliac artery and vein in 1, the external iliac artery and vein in 1, and the common iliac vein alone in 1. These groups are individually too small to make any comparisons as to varying prognosis when one or another structure is involved but it is felt that as larger numbers are reported differences in outlook will become apparent based on differences in the additional lymphatic networks concerned. Our limited experience to date suggests that the ability of the several adjacent anatomic structures to resist invasion by the bowel tumor does vary, however. In eight patients presenting firm fixation to the prostate, actual involvement of that gland was present in only two. It seems likely that the prostatic capsular fascia is largely responsible for this resistance to prostatic invasion. By contrast, successful invasion of the vagina had occurred in 10 out of 16 instances in which it was removed.

Among the 42 cases there were 8 postoperative deaths, an operative mortality of 19 per cent. Of these, 1 occurred as a result of shock, 1 as a result of uremia 4 days postoperative, following resection of a portion of ureter with ligation of its proximal end rather than reimplantation, 1 following a second operation 12 days postresection for the relief of intestinal obstruction, and I occurred as a result of necrosing arteritis of the common iliac artery, established at autopsy, 16 days after resection for a lesion complicated by a large lateral pelvic wall abscess. There were two deaths from large pulmonary emboli, confirmed at postmortem examination, 4 days and 3 weeks, respectively, after operation and two deaths from general inanition irremediable by any means with terminal pneumonia 2 and 5 weeks postoperative, respectively. The death from uremia was the only one directly attributable to the extent of the procedure, though there is little doubt but that such extension was a contributing cause in the others.

FIG. 5.—(Case 3452) : Uterus, tubes, ovaries and loop of ileum adherent to rectal specimen. Though there was no demonstrable invasion of these structures microscopic invasion of the extracolic fat would indicate the danger of dissecting them off.

TABLE II

TABULATED CASES OF LARGE BOWEL RESECTION ACCOMPANIED BY THE REMOVAL OF ADDITIONAL STRUCTURES

Case No.	Age	Location of Tumor	Operative Procedure	Structures Removed	Demonstrable Involvement of Other Structures	Subsequent Course
1783	69	Lower rectum	Miles' resection	Post. vaginal wall	Positive	Died 22 mos. postop.
2090	34	Lower rectum	Miles' resection	Post. vaginal wall	Positive	Metastases 53 mos. P.O.
2095	45	Rectum	Miles' resection	Post. vaginal wall	Negative	Well 4.5 years
2242	56	Rectum	Miles' resection	Post. vaginal wall	Negative	Recurrence & metas. 43 mos. P.O.
5016	62	Lower rectum	Miles' resection	Post. vaginal wall	Negative	Pulmonary metas. 15 mos. P.O.
5448	61	Rectum	Miles' resection	Post. vaginal wall	Negative	Well 18 mos. P.O.
5854	72	Rectum	Miles' resection	Post. vaginal wall	Negative	P.O. death 2 wks. in-anition & pneumonia
5431	69	Low sigmoid	Miles' resection	Left ovary and tube	Negative	Well 1 year P.O.
1828	64	Rectosigmoid	Miles' resection	Cervix	Negative	Died 22 mos. P.O.
2958	55	Rectosigmoid	Miles' resection	Uterus, tubes, ovaries	Negative	P.O. death, shock
3774	31	Rectosigmoid	Two-stage Lahey	Uterus, tubes, ovaries	Negative	Well 3 years
6145	43	Rectosigmoid	Miles' resection	Uterus, tubes, ovaries	Negative	Well 5 months
2688	71	Rectum	Miles' resection	Uterus, tubes, ovaries, post. vaginal wall	Positive	Well 40 months
2811	65	Rectum	Miles' resection	Uterus, tubes, ovaries, post. vaginal wall	Negative	Well 33 months
3056	59	Rectum	Miles' resection	Uterus, tubes, ovaries, post. vaginal wall	Positive	Died 8 months P.O.
3500	65	Rectum	Miles' resection	Uterus, tubes, ovaries, post. vaginal wall	Positive	Well 39 months
5849	17	Rectum	Miles' resection	Uterus, entire vagina	Positive	Recurrence 13 months
6173	67	Rectum	Miles' resection	Uterus, tubes, ovaries, entire vagina	Positive	Recurrence 13 months
6686	62	Rectum	Miles' resection	Uterus, tubes, ovaries, entire vagina	Positive	Well 8 months
6715	37	Rectum	Miles' resection	Uterus, tubes, ovaries, entire vagina	Positive	Well 7 months
504	57	Rectum	Miles' resection	Retrourethral prostate and seminal vesicles	Negative	Well 52 months
1670	60	Rectum	Miles' resection	Retrourethral prostate and seminal vesicles	Negative	Suicide 10 months
2252	34	Rectum	Miles' resection	Retrourethral prostate and seminal vesicles	Negative	Died of disease 33 mos.
2534	61	Rectum	Miles' resection	Retrourethral prostate and seminal vesicles	Positive	P.O. death 12 days, intestinal obstruction
3102	68	Rectum	Miles' resection	Retrourethral prostate and seminal vesicles	Negative	Died 3 months
3582	58	Rectum	Miles' resection	Retrourethral prostate and seminal vesicles	Negative	Died 7 months
5865	50	Rectum	Miles' resection	Retrourethral prostate and seminal vesicles	Negative	Well 17 months
7298	63	Rectum	Miles' resection	Retrourethral prostate and seminal vesicles	Positive	Well 2 months
3296	55	Sigmoid	Resection—anastomosis	Posterolateral bladder wall + common iliac vein	Positive	Died of recurrence 39 mos. P.O.
3751	45	Rectosigmoid	Miles' resection	Entire post. bladder wall	Negative	Died of recurrence 8 mos. P.O.
5498	70	Rectosigmoid	Two-stage Lahey	Entire post. bladder wall	Positive	Well 18 months later
2579	58	Low sigmoid	Resection—anastomosis	Segment of ileum, left tube and ovary	Positive	P.O. death, uremia
3019	48	Rectosigmoid	Miles' resection	Segment of ileum	Positive	P.O. death (embolus)
3452	48	Rectosigmoid	Miles' resection	Segment of ileum, uterus, tubes, ovaries	Negative	Alive and well 3.5 years later

TABLE II (Continued)

Case No.	Age	Location of Tumor	Operative Procedure	Structures Removed	Demonstrable Involvement of Other Structures	Subsequent Course
7207	59	Low sigmoid	Hartman resection	Segment of ileum and bladder	Positive	P.O. death 2 wks.—wound hemorrhage
7223	59	Cecum	Right colectomy (Mikulicz)	Right ext. iliac artery & vein + segment right ureter	Positive	P.O. death (embolus) 3 weeks
2023	78	Cecum	Right colectomy with anastomosis	Large area ant. abdominal wall	Positive	P.O. death 5 wks. inanition
3135	58	Right colon	Right colectomy with anastomosis	Iliopsoas muscle (entire)	Negative	Died 23 months later
4921	55	Right colon	Right colectomy (Mikulicz)	Large segment ant. abdominal wall + iliac muscle + femoral nerve	Positive	Well 28 months
5022	68	Splenic flexure	Resection	Entire wall to skin	Negative	Well 24 months
6192	72	Sigmoid (recurrent)	Miles' resection	Large area of anterior abdominal wall	Positive	Well 1 year later
7744	72	Rectum	Miles' resection	Posterior vaginal wall	Positive	Very recent

Fifteen patients are dead of, or are living with, recurrent or metastatic disease. The remaining 19 are alive and apparently well. Two of these have lived from 4 to 5 years, four from 3 to 4 years, three from 2 to 3 years, five from 1 to 2 years and five less than one year since operation.

COMMENT: That these extensive procedures are worth while is attested to by the fact that evidence of spread beyond the local lesion was absent in 41 per cent of cases and that a fair number of these patients have already survived for considerable periods. It is hoped that additional reports of similar series of cases will be forthcoming so that as the numbers increase a better appraisal of these extended resections may be obtained than is at present available, first regarding the entire group and second regarding the resection of the individual structures above mentioned. For example, it is suggested that coincident resection of abdominal wall or vagina will prove to be far more advantageous than removal of iliac vessels or the bladder. Involvement to the serosa in 79 per cent of patients in whom resection of the bowel alone was accomplished suggests the advisability of resecting adjacent attached structures more frequently with less indication than marked fixation to them as has usually been true in the past. It is conceivable that more cures will result from such a course than from resecting adjacent organs in which direct invasion is demonstrable. The treatment of cancer of the colon and rectum has been considerably clarified in recent years.[1] The justification of and indications for the coincident removal of additional structures remains, however, as one of the unsolved aspects of the problem in which further enlightenment is needed.

SUMMARY

(1) As a result of a tendency toward increasing radicalism in dealing with carcinomas of the large bowel, more frequent attempts are being made to remove tumors which are definitely, or are suspected of invading adjacent structures.

(2) Forty-two such cases in which additional organs were removed in order to accomplish removal of a rectal or colonic cancer are presented.

(3) The poorer general condition of these patients, as well as the increased extent of the operations, as compared to the usual types of colon resection is reflected in an appreciably higher operative mortality.

(4) Justification for such procedures is indicated by the fact that apart from involvement of all layers of the bowel wall, other unfavorable pathologic signs were absent in 41 per cent of the cases and by the fact that 19 of 34 patients surviving operation are still living for considerable periods.

(5) It is suggested that the reporting of more such cases will contribute to a much needed clarification of the indications for these extended resections.

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CHOLEDOCHUS CYST

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A CASE OF CHOLEDOCHUS CYST is presented differing in certain aspects from others already reported; the diagnosis was arrived at preoperatively (as nearly as that is possible in such an obscure condition) and the operative treatment included some steps which had not been previously employed.

Choledochus cyst is an interesting condition, both from the pathologic and clinical standpoints. Judd and Green,[1] at the Mayo Clinic, demonstrated its rarity when they reported finding but one case out of 17,381 in a review of the records of operations upon the biliary system for a 20-year period. Smith,[2] in searching through the records of the Presbyterian Hospital, in New York City, covered 757,000 and found but two cases. The total number of reported cases as given in articles which contain a review of the literature on the subject varies somewhat according to the authors' interpretations of what cases should be included. Smith,[2] for instance, collected 181 cases while Shallow, Egger, and Wagoner,[3] in an article a year later, were able to find but 175. The total probably is under 200. Vinninger and Cash[4] covered the subject very thoroughly and their article, though written in 1932, is still regarded as an excellent reference. It contained one of the first reviews of the literature on choledochus cyst and goes into etiology, pathology, *etc.*, very systematically.

As to *etiology,* the consensus of opinion both from this and from other articles, seems to be that in the case of a true cyst of this type, the condition is one of congenital maldevelopment of the common bile duct. For a meticulous description of the relevant normal and pathologic embryology, one can find none better than that given by Swartley and Weeder[5] in a paper primarily concerned with the reporting of an extremely unusual form of this rare condition, a "choledochus cyst with a double common bile duct." In subsequent writings on this same case, Weeder,[6] and Swartley[7] make further pertinent observation on the embryology. Among the things these and other writers speculate upon, are the possible "exciting" factors which precipitate symptoms in an anomaly presumably present since birth. The thing which brings on trouble probably varies in each individual case. Obstruction, partial or complete, is nearly always the mechanism responsible for the onset of difficulties. Trauma and inflammation must be seriously considered as exciting factors. Disproportionate growth of one part of the altered biliary system in relation to another may in time result in torsion and narrowing of the passageways. But it is almost impossible in most instances to tell what has changed a silent lesion of this sort into an active one.

The condition is said to occur more often in the female than in the male, and more often in children than in adults.

A triad of *signs and symptoms* seems to have been noted repeatedly enough in the various studies to be called the usual clinical picture. These are (1) abdominal pain; (2) tumor mass; and (3) jaundice. Roentgenologic studies

FIG. 1.—Plain film of the abdomen: Patient lies on his back. The mass is seen to occupy most of the right side of the abdomen. In this position, the fluid is posterior and the gas has risen to the anterior portion of the cyst, therefore, the shadow seen in the picture is cast by the overlying gas.

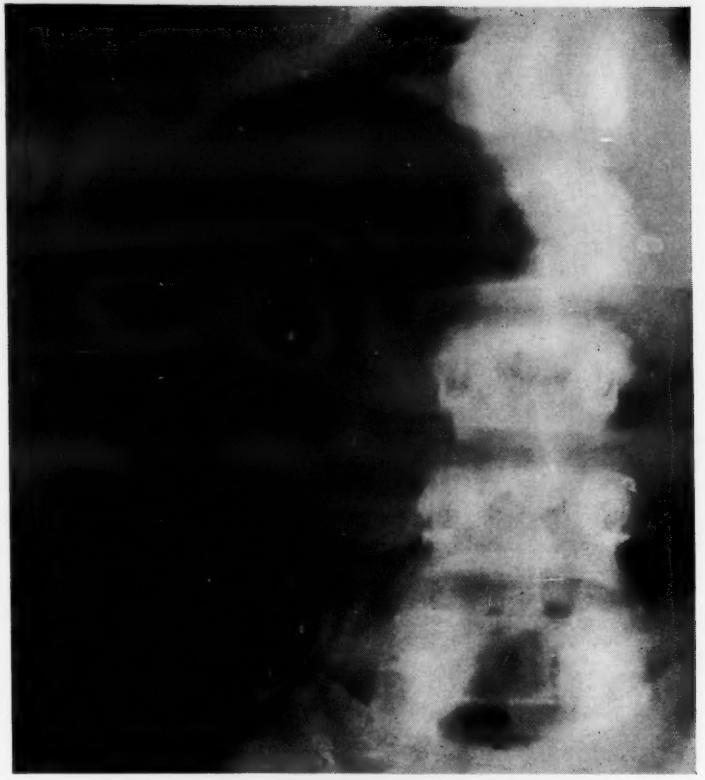

FIG. 2.—Plain film taken of the patient in the upright position shows the outline of the upper portion of the cyst. A fluid level is clearly demonstrated and the gas above it also evident. A second and smaller collection of gas is seen above the dome of the cyst and toward the midline.

probably contribute more accurate information than any other artificial aid. Liver function studies sometimes are of value, and tests for jaundice are at times a definite help.

As to the *course*, it is conceivable that some choledochus cysts never have given trouble. Once blockage has occurred, however, the course is progressively downgrade and death eventually ensues. If the obstruction is acute or relatively so, cyst rupture and peritonitis may kill the patient; if less acute, high

FIG. 3

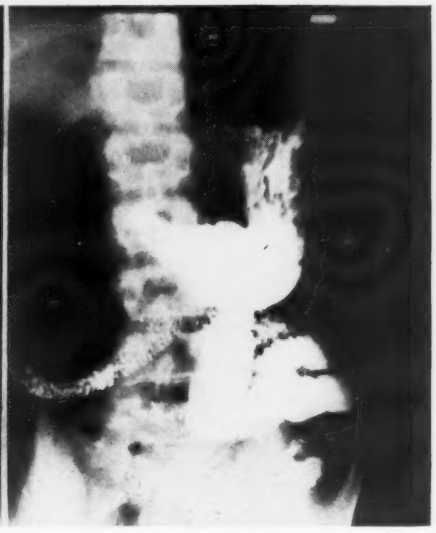

FIG. 4

FIG. 3.—Roentgenogram taken with the patient in the upright position and in conjunction with the gastro-intestinal study. In this film, the fluid level and the overlying gas within the cyst is again demonstrated. The small separate collection of gas is noted just above the dome of the cyst as in Fig. 2; however, in this film, the barium demonstrates the location of the transverse colon and eliminates gas in this structure as accounting for the shadow above the cystic mass.

FIG. 4.—Roentgenogram demonstrates the shadow of the gas in the top of the cyst plus the small gas shadow just above the cyst, and the outline of the stomach, duodenum and jejunum. The position of the stomach and the small bowel in relation to the gas shadow superior to the dome of the cyst clearly demonstrates that this collection of gas is not one in an overlying portion of the gastro-intestinal tract. Furthermore, its constancy in varied stages of the gastro-intestinal study also tend to establish it as being contained in a fixed structure in that region. This film also shows how the cyst has stretched out the second and third portions of the duodenum. Apparently, part of the cyst has insinuated itself within the duodenal loop.

intestinal obstruction or a progressive obstructive jaundice with liver damage and general toxemia may be the direct causes of death. Should the disease be a prolonged one and the interference with bile flow incomplete, it is conceivable that changes of the type seen in biliary cirrhosis could take place in the liver with secondary enlargement of the spleen. This was the observed succession of events in one case where a second operation and later an autopsy permitted a direct check on the progress of the disease. The case was atypical, the cyst involving the right of two "common bile ducts." The cystic right duct drained the right hepatic lobe; the other, the left. The right duct was completely extirpated and successively a shrinkage of the right lobe of the liver with compensatory enlargement of the left lobe and a subsequent enlargement of the

spleen took place. The patient developed a thrombocytopenia and died after many hemorrhages. Section of the right lobe of the liver showed changes suggestive of cirrhosis. The whole clinical picture resembled an induced Banti's disease. (Case of Swartley and Weeder,[6] with an interesting discussion by Dr. Allen O. Whipple.)

FIG. 5.—A roentgenogram which resolves the question as to where the duodenum runs in relation to the cyst. The course of the barium from the pylorus is downward and forward, so that the duodenum may be said to be displaced forward by the mass and to lie anterior to it. This picture is taken transversely. The stomach can be seen in somewhat hour-glass shape, the barium narrowing down in the center and widening out superiorly and inferiorly. Beyond the stomach, the dome of the cyst filled with air is visible and the fluid level is again noted.

Treatment is obviously surgical, and has not been too successful. In a series of cases reviewed by Shallow, Egger, and Wagoner, the over-all mortality was 58 per cent. Primary anastomosis of the biliary and intestinal tracts gave a mortality of 27 per cent, simple drainage of the cyst, a mortality of 88 per cent, and if the condition was recognized and no operation undertaken, a 100 per cent fatality. Ladd and Gross[8] are somewhat more optimistic about the results of direct anastomosis between the biliary tract and intestine; reporting but a 9 per cent mortality, though the general mortality for cases treated by various methods in their series was 69 per cent.

Case Report.—A colored male, age 22, was admitted, 23 November, 1944, with the chief complaint that he was "not able to eat as much" because of a "knot" in the upper right side of his abdomen. This had been noted during the past five months, prior to that he had been well and had served for one and one-half years in the Army, doing regular duty. The symptoms were actually a soreness and a fullness after meals, felt in the

FIG. 6

FIG. 7

FIG. 6.—A roentgenogram which contributes further to the outlining of the mass. Patient is lying on the abdomen and the film is taken transversely. The enclosed air again rises, and what is actually the posterior portion of the cyst is now clearly demonstrated.

FIG. 7.—With the patient lying on the left side an A.P. view was taken, and demonstrated the outline of the cyst further. Lateral portion of it is now filled with the gas which has risen; the central portion of the cyst is filled with fluid and does not show up.

epigastrium and, while his appetite continued good, he could not eat as much as he wanted to because of the distress which came on after ingesting a small quantity of food; as this grew worse, he cut down more and more on the quantity and finally began to skip meals. As a result, he lost 25 pounds in weight, most of it in the two months immediately prior to admission. As this postprandial distress became worse, especially once after a session on the obstacle course, the soldier went on sick call a few times, and one week before his hospitalization was admitted to another Army hospital where studies were made, and a cystic mass in the upper right quadrant was demonstrated roentgenographically.

The patient had been a farmer in Tennessee before coming into the Army, and had had no service out of this country. He drank moderately. His father, mother and sis-

ter were all living and well. As a child, he had had measles and chicken pox and, at 16 years of age, had fractured his left ankle. Syphilis was denied but he had been getting weekly injections for some unknown condition. One year ago, he had had gonorrheal infection.

FIG. 8

FIG. 9

FIG. 8.—Patient lying on right side, the inner contour of cyst is shown by the bubble of enclosed gas which, again, has risen to the uppermost portion of the cyst. This film, plus the foregoing films taken in other positions, demonstrate the cystic mass to be elliptical in outline in the vertical plane. Its walls, apparently, are rather firm or, at least, fixed to adjacent structures, since in none of the different positions is it seen to be collapsed even partially.

FIG. 9.—Retrograde pyelograms show normal kidney, pelvis and ureter outlines on both sides. The mass does not seem to impinge upon the kidney or on the urinary tract, nor does it seem to be a part of either.

Physical Examination: A tall, lanky, young Negro was encountered who looked a bit "draggy," and showed that he had lost weight. No jaundice was noted. The various parts of the body were carefully checked and were found to be within normal limits, except for the abdomen. Here, a "fullness in the right upper quadrant extending to the

midline and to about five finger's breadth below the costal margin" was noted. The mass was described, both as "doughy" and "cystic" to palpation, and was tender. No other masses or tender areas were found.

Laboratory studies showed the following:

1. Blood counts. These varied rather widely when taken on three occasions, with a two-week period, therefore, each report is given:

a. R.B.C. 5,200,000, Hb. 15.9 Gm.; (101%); W.B.C. 6,400, P. 19%, L. 72%. M. 9%, E. 2%.

b. R.B.C. 4,420,000, Hb. 12.5 Gm.; W.B.C. 5,000, P. 37%, L. 63%, MCV. 73, MCH. 29, MCC. 39.

c. R.B.C. 5,450,000, Hb. 11.5 Gm.; W.B.C. 20,600, P. 91, L. 9.

FIG. 10.—Barium meal given one month postoperatively shows the absence of the cystic mass, and a flattening all along the upper part of the duodenum where anastomosis between the dome of the cyst and this part of the bowel had been effected. Absence of gas in the gallbladder is noted, and it is also noteworthy that the barium does not extend up the cystic duct or the common hepatic duct.

2. Clotting time 7 minutes, 15 seconds

3. Urine: Yellow, cloudy, sp. gr. 1021, acid, albumen plus two, sugar 0, Negative for pus, blood or casts.

4. Icteric index 5.

5. Kahn, negative.

6. Heterophile antibody, negative.

7. Serum amylase 81 mg. per 100 cc. of reducing substance, produced by the enzyme (Zomogi).

8. Stool for parasites and ova, none seen.

9. Prothrombin time 114 per cent of normal.

10. Blood type—A.

Roentgenologic studies demonstrated the following (see Figs. 1 to 10):

1. 18 November, 1944: "large ovoid mass, right upper quadrant displacing the hepatic flexure caudally."

2. 18 November, 1944: "ovoid cystic mass containing about one-third gas in the right upper quadrant below the liver. Gas-containing small bowel anterior to the mass may represent duodenum. *Irregular gas pockets superior to the mass represents an extension from the tumor.* Nonfunctioning gallbladder. Fluoroscopy of the stomach and small intestine demonstrates an enlargement of the duodenal curve, which is displaced anteriorly. Large pancreatic cyst arising from the head of the pancreas."

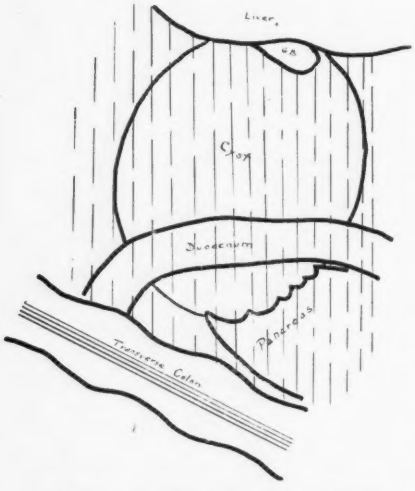

FIG. 11.—This illustration demonstrates the situation as it was encountered upon opening the abdomen. A veil of transparent and translucent peritoneum like tissue extended from under the liver margin down to the transverse colon. Beneath it, a tense cystic mass was visible and palpable. On the anterior surface of this mass, a segment of intestine, later identified as the duodenum, was found coursing downward and outward. From under the liver margin, the fundus of the gallbladder protruded and was not covered by any veil. It was filled with gas. The pancreas occupied a position under the veil and within the curve of the duodenum closely adherent to the inner lower wall of the cyst and represented in the illustration by the irregular line depicting the way in which the head was cupped about the internal portion of the cyst wall.

3. 21 November, 1944: "normal intravenous urograms, calices are only fractionally visualized on the left. Portion of the ureter between the second and third lumbar vertebra on the right fails to fill as the result of pressure from the extrinsic mass. Stereo film demonstrates right kidney to be in the usual position posteriorly."

4. 25 November, 1944: "same large mass in the right side of the abdominal cavity is evidently still present. This contains a large amount of fluid and also a considerable quantity of gas, so that the fluid level is easily made out in both upright and horizontal positions. Impression deferred. Further studies indicated."

5. 25 November, 1944: "further films show the same large mass in the right side of the abdominal cavity, containing a large quantity of gas, and a large amount of fluid."

6. 28 November, 1944: "the retrograde study with cystoscopy and catheterization of both ureters, showed essentially normal appearing calices and renal pelves. There was no evidence of any connection between the upper urinary tract and the large cystic mass on the right upper and middle quadrant.

Operation.—29 November, 1944: The abdomen was opened through a high right rectus incision. A large cystic mass was immediately apparent in the upper right quadrant, covered with a veil of peritoneum-like tissue (Fig. 11). It was impossible to clearly identify it immediately. A loop of small bowel crossed the anterior surface of the cyst diagonally from the above downward and from left to right, also under the veil—it was duodenum. Other organs in the abdomen were normal. The veil was split, and by blunt and sharp dissection, freeing of the cyst was begun. During the freeing process, the head of the pancreas was identified as cupping about the left side of the mass. There was a "pedicle" two centimeters in length, later shown to be the lower portion of the common

duct running between the lower portion of the cyst and the second portion of the duodenum. The cyst wall was punctured near the lower pole and clear light bile exuded. Yellow bile and "mud" were also seen within. Aspiration netted about 1000 cc. of chalky-yellow material and light bile. The lower end of the cyst was detached, and the main mass freed upward. The duct entering the duodenum was probed, found to be a true duct, and then clamped. The duct was later inverted into the wall of the duodenum, and the peritoneum plicated over it. Separation to the left, from the head of the pancreas was accomplished without difficulty. At the top, the gallbladder was seen protruding between the dome of the cyst and the edge of the liver uncovered by any membrane. It was bluish-white, pale, translucent, and filled with gas. It could be squeezed and emptied of its gas like a small balloon, and would refill on releasing pressure. Further freeing of the cyst exposed the structures above—the cystic duct and the common hepatic duct. These were normal in appearance and arrangement. They entered the dome of the cyst separately (Fig. 12). (It is well to pause and remark that up to this point what was being done was in effect an intra-abdominal, operative, differential diagnosis. One does not simply enter the abdomen and immediately identify a choledochus cyst or a pancreatic tcyst or any other of the more obscure cysts or tumors.)

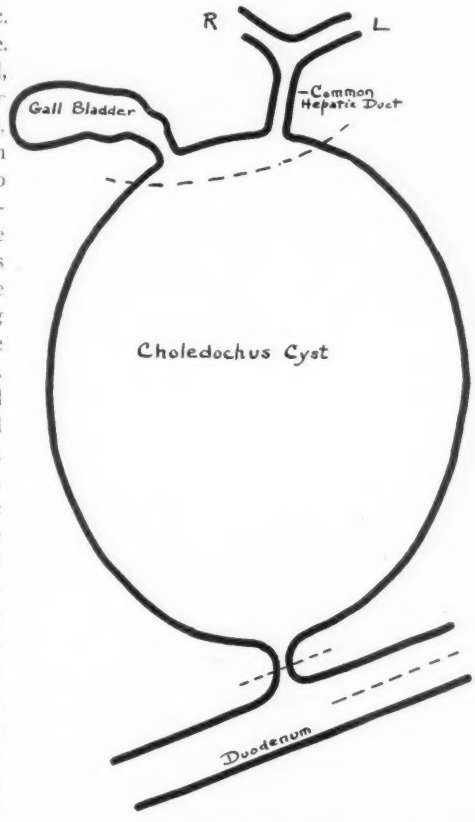

FIG. 12.—This illustration shows the arrangement after dissection. The gallbladder above connects directly with the cyst through its cystic duct. The common hepatic duct communicates directly with the cyst and from it branch off the right hepatic duct and the left hepatic duct. The cyst, itself, was found to communicate directly with the duodenum at its lower end through a patulous duct of about 7.5 millimeters external diameter. The dotted lines show from above downward the site at which the cyst was severed from its own dome. The point at which the duct leading from the cyst to the duodenum was severed is indicated as is also the line of incision on the duodenum where the anastomosis between the cyst dome and that structure was effected.

A small portion of the dome into which the ducsts entered was left and the rest of the cyst cut away. This small dome was then anastomosed to the duodenum (Fig. 13). A cigarette drain was inserted to the operative field, and the abdomen was closed in layers.

Postoperatively, the patient's course was not eventful. He had a postoperative anemia which responded to transfusion. For a few days he was jaundiced. On the third postoperative day, his icteric index was 25 and on the sixth postoperative day, it had come down to 13. He never did have clay-colored stools, however. There was no bile drainage from the wound. The cigarette drain was removed on the fourth postoperative day and the sutures were removed, and the wound healed on the ninth day. The patient was up on the fourteenth day. After that, he ate regular diet, gained weight and continued to have formed stools of normal color. He had had a little transient diarrhea on his third and fourth days.

It was not possible to demonstrate the gallbladder by the usual dye technic one month after operation. Roentgenograms of the G.I. tract showed the duodenum well outlined, and there was no extension of the barium into the biliary system. Seventy-nine days after admission, the man was discharged to duty, having gained approximately 25 pounds during his hospital stay.

The pathologic examination of the cyst wall showed it to be mostly fibrous tissue without a lining epithelium but with some duct-like structures in part of the wall (Figs. 14, 15 and 16).

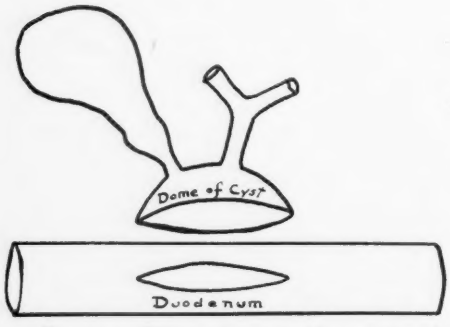

FIG. 13.—Shows the type of anastomosis undertaken in this case. A small cap of the dome of the cyst was allowed to remain and this was joined to the duodenum. Leading into this cap are shown the cystic duct from the gallbladder and the common hepatic duct.

DISCUSSION.—It is almost an impossibility to make an absolute diagnosis of a choledochus cyst preoperatively. In the present instance, it headed a list of diagnoses, including pancreatic cyst, retroperitoneal cyst, liver cyst, *etc.*, and was given by the operator as his preoperative preference. After all, as Swartley emphasizes, it is the preoperative suspicion of the presence of a choledochus cyst that makes dealing with it in the abdomen more effective, lessens mortality and improves results. From a purely statistical standpoint this patient should not have been one to excite suspicion that he was afflicted with a choledochus cyst—he was an adult, not a child, male not female, and of a race in which the lesion has not often been found. Of the three "pathognomonic" signs of choledochus cyst —pain, tumor mass and jaundice—two were definitely present. The patient had distressing pains and he had the tumor mass. Jaundice was absent both clinically and by laboratory determination. The roentgenograms were of greatest help, for they confirmed the presence of the mass, showed it to be cystic and showed that it contained gas. The inability to demonstrate a normal gallbladder in a young man, age 22, suggested involvement of the biliary tract. Taking the pictures with the patient in various positions was extremely helpful in outlining the walls of the mass and in showing something of the nature of these walls—the failure to collapse in various positions for instance. Identification of the air within the cyst was of significance, and the fluid level indicated the presence and amount of liquid within it. The gas in the gallbladder is visible in the films and, as described by the roentgenologist, "seemed to emerge from part of the tumor." Its full significance was not appreciated before the abdomen was opened. It should be looked for in future cases, and may be regarded as a finding of utmost value. Being isolated so exactly in the different views, it obviously was not gas within loops of the bowel itself; its constancy of position precluded its being free air under the diaphragm. The logical inference is that the gas in the cyst and that trapped in the gallbladder came from the intestinal tract *via* the communication between

the cyst and the duodenum. Fluoroscopy in which the duodenum was demonstrated as crossing in front of the cyst, was extremely valuable, and the roentgenograms showing the stomach from the side, with barium in it and the barium continuing down in the duodenum in front of the cystic mass, is also of value. Of diagnostic value from the negative standpoint, was the fact that the gastro-intestinal tract appeared normal—the cystic mass not arising from a part of the intestine. The normal urinary tract visualization had a similar

FIG. 14.—Photomicrogram showing: "No specific living cells are noted on the free surface, and the free surface has poor staining characteristics, suggesting early stages of necrosis."
The section shows what is usually seen in sections of these walls—the absence of a living epithelium.

value in eliminating, almost completely, the possibility of the mass being a kidney lesion. Laboratory studies were of little value; the confusing picture from the blood count was not of help. The leukopenia apparently was fairly constant and perhaps it was some inflammatory change which elevated the leukocyte count and called for the numerous polymorphonuclear cells reported in the examination immediately before surgery.

The most plausible diagnostic possibilities, other than choledochus cyst, were pancreatic cyst, solitary cyst of the kidney, hepatic cyst and "retroperitoneal" cyst.

Pancreatic cyst could not be ruled out, but such cysts are usually not so completely and so far to the right. If they extend to the right there is usually a goodly portion still in the middle or even to the left. The ordinary pancreatic cyst is not gas-containing. The findings of a normal serum amylase meant little.

Solitary cyst of the kidney, which can closely resemble the size and situation of a choledochus cyst such as this one, was pretty well eliminated by the normal urograms. These cysts usually displace the kidney and distort the shadows of the calices. Also they rarely contain gas (See Fig. 17).

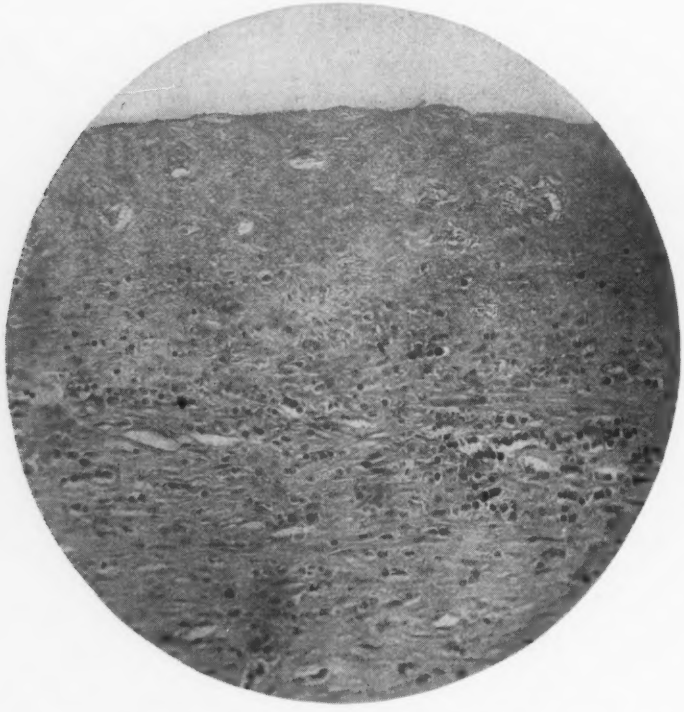

FIG. 15.—Photomicrogram showing: "The entire wall is of considerable thickness and is composed of parallel and interlacing fibers of coarse connective tissue. Between these fibers are numerous nests of chronic inflammatory cells and many capillary-size blood vessels."

This section shows well the nondescript fibrous tissue make-up of the thick wall of these cysts.

Echinococcus cyst of the liver was not completely ruled out by the absence of parasites and ova in the stools. The absence of eosinophils in two of three preoperative differential white cell counts, and the presence of but 2 per cent in the third, is of more weight. Calcium is sometimes seen in the walls of an echinococcus cyst, especially the older ones, and at times daughter cysts can be made out; such was not the case here.

"Retroperitoneal cysts" or cystic tumors or "reduplication of the gastroin-

testinal tract" (Ladd) may mimic any of the other unusual lesions; they could not be completely ruled out in this patient. Some of this group arise along the base of the mesentery and occupy approximately a midabdominal position. Omental cysts are more moveable than the choledochus variety. Only those "reduplications" arising directly from the intestine, as "massive diverticula" contain gas, and in these the walls may be less thick and firm than those in choledochus cysts—certainly than the cyst walls demonstrated in the present case. Roentgenologic studies of the whole gastro-intestinal tract showed no peregrinations of the barium into the mass in question.

FIG. 16.—Photomicrogram showing: "At one edge of the section, small glandular spaces are noted lined by medium, tall, pale columnar epithelial cells somewhat resembling the type of cell seen lining gallbladder walls. This area somewhat resembles the intramural type of glandular proliferation seen in cholecystitis glandularis proliferans. Around the glandular areas, there is an especially noticeable concentration of chronic inflammatory cells."

Choledochus cyst was placed first on the list of possibilities preoperatively, because of (1) the finding of an ovoid mass; (2) its location in the right upper quadrant; (3) the pressure symptoms associated with it (distress after eating); (4) its cystic nature; (5) the presence of gas within it; (6) the altered gallbladder function, as shown by the Cole-Graham technic, and (7) the unlikelihood of the presence of some of the other possibilities.

In treating this condition, surgery obviously is the method of choice. Good

anesthesia is of prime importance, and the continuous spinal method is a most satisfactory one. With the abdomen open, the first problem is one of identification and orientation. It takes some time before one can accomplish enough dissection, and that very carefully, to identify the pathologic lesion with which one is dealing (in this case the enveloping veil made injury to the duodenum and pancreas a likely possibility). This is the answer to those who would say

FIG. 17.—Roentgenogram taken in the case of a large solitary cyst of the lower pole of the left kidney. The cyst was comparable in size to the choledochus cyst. It shows the following contrasting points however: 1. The absence of gas. 2. The upward displacement of the kidney. 3. The distortion of the kidney pelvis.

that the treatment should be a simple anastomosis between the cyst wall and some segment of the gastro-intestinal tract. In the first place, the amount of dissection and separation necessary carries the operation beyond the simple stage. Secondly, to anastomose an unidentified cyst to intestine is bad surgery. Since the physical presence of the cyst itself gives rise to symptoms, its extirpation seems to be a logical step.

The duct leading from the cyst into the duodenum in this patient appeared to be a very real and patulous one, about the diameter of the lower end of a normal common duct. Apparently, the reason why this cyst did not give rise

to symptoms of biliary tract obstruction was that no constriction of the lumen of the duct *per se* existed. The onset of jaundice was imminent though, for the cyst contained such thick material that interference with complete emptying was only a matter of time. Most of the symptoms that were produced were the direct result of the pressure exerted by a mass of this size on adjacent organs, *i.e.*, on the stomach, pylorus and duodenum.

As to choice of operative procedure, this must largely depend on the findings in the individual case. The prime aims are to reëstablish an unobstructed flow of bile into the gastro-intestinal tract and to remove or reduce in size the symptom-giving mass. In the present case, after dissection, the right and left hepatic ducts were isolated and were seen to join and form an apparently normal common hepatic duct, which entered the dome of the cyst; one and one-half centimeters to the right of this the cystic duct entered separately.

The decision was made to remove all the cyst except that small portion of the dome into which these ducts emptied and to anastomose this "dome" to the duodenum. This was mechanically simpler than using the common hepatic duct alone. Because the suture line was removed from the immediate termination of the hepatic duct, subsequent contracture of its ostium was less likely than if the duct itself had been directly concerned in the anastomosis. This method of approach also reduced the total operating time, already extended, by that which would have been consumed in removing the gallbladder. There seemed little hope that the bile would ever enter this gallbladder, yet, on the other hand, it was unlikely that duodenal contents would enter either, since the cystic duct presumably retained its valve-like structure intact. (Roentgenograms, taken later, showed no extension of barium into the biliary system—either into the cystic or hepatic ducts.) Then, too, this apparently inert and functionless gallbladder, if left in place, might prove useful in the construction of an alternate pathway for bile should an unexpected biliary obstruction develop postoperatively.

The operative anastomosis, as decided upon, went well, and the uncomplicated postoperative course seems to establish the steps herein taken as a different and acceptable means of dealing with a choledochus cyst.

SUMMARY

1. A case of that rare pathologic lesion choledochus cyst is reported. This case is unique in that the patient was a Negro, and that the diagnosis was placed first among preoperative choices. Anticipating the possible presence of this lesion is more important than making an exclusive diagnosis.

2. Roentgenologic examination was of extreme help in the evaluation:
   a. By directing attention to the biliary tract in the finding of a "nonfunctioning gallbladder."
   b. In outlining the cyst by means of views taken from various positions.
   c. In demonstrating relation of the cyst to the gastro-intestinal tract.
   d. By showing the presence of gas in the gallbladder above the cyst—a finding which, when present, would strongly hint at the diagnosis.

3. Operation consisted of removal of approximately nine-tenths of the cyst and anastomosis of the remaining portion of the dome (that part into which the cystic and common hepatic ducts entered) to the duodenum. The operation herein described is a practical and technically simple method of accomplishing anastomosis and, judging by the clinical results in this case, a very satisfactory one.

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REPEATED MASSIVE INTESTINAL HEMORRHAGE

REPORT OF AN UNUSUAL CASE

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MASSIVE BLEEDING from the upper gastro-intestinal tract is not uncommon with an ulcer of the stomach or the duodenum when the ulceration erodes into a large vessel, with tumors of the stomach, or with tumors of the small bowel. This case, however, is considered important because of the unusual etiology of the hemorrhage, the extent of the bleeding, and the amount of blood replacement therapy which was necessary in a short period of time. It is also considered worth while recording because of the possibility of similar cases occurring as the result of war injuries.

Case Report.—A member of an infantry unit on combat duty near Heilbronn, Germany, was struck in the left midaxillary line with shrapnel, on April 9, 1945, at about 1600, receiving a thoraco-abdominal wound. He received emergency treatment in the field consisting of compression dressing, ¼ grain morphine, 4 Gm. sulfadiazine by mouth, and 2,000 units of penicillin. At 1900 on the same day he was admitted to a Field Hospital, where 500 cc. of plasma and 500 cc. of blood were administered. At 2100 he was operated upon under intratracheal ether and oxygen anesthesia. Preoperative blood pressure was 144/98; pulse 90.

The wound of entry was at the level of the seventh interspace. The chest was explored; the missile was thought to be lying below the left diaphragm, which had been lacerated. The wound of entry was débrided; and the sucking chest wound was closed. A formal thoracotomy was then performed through the left ninth interspace. The laceration of the diaphragm was seen to have a small amount of omentum herniating through it into the pleural cavity. The diaphragm was opened widely for exploration of the left upper quadrant. The missile found lying in the peritoneal cavity was removed. The spleen was lacerated. Splenectomy was performed, with double ligation of the pedicle. Four perforations of a segment of upper jejunum were found. These were closed with two rows of sutures. A through-and-through perforation of the transverse colon just proximal to the splenic flexure was exteriorized through a left subcostal stab wound, after closing the two perforations. The diaphragm was closed with interrupted sutures of heavy black silk. A thoracotomy tube was placed in the left costophrenic angle, and a small catheter in the second interspace anteriorly. Twenty-five thousand units of penicillin were placed in the pleural cavity. The chest wall was closed in layers.

Postoperative course was uneventful. On the second day 120 cc. of serous fluid and 240 cc. of air were evacuated from the left chest. He was evacuated by air from Germany to Paris on the 20th of April, where he was held for further evacuation to the Zone of Interior. Check-roentgenograms on the 23rd of April showed some haziness of the left lower lung fields, but "significant regression of the diffuse reaction noted on previous films" was observed. The remaining residuum was thought to represent a regressive pleural effusion. On 1 May, 1945, in Paris, moderate bleeding was noted from the colostomy wound. He was transported by air to the Zone of Interior, arriving at the Regional Hospital at Mitchel Field on 2 May, 1945.

At about 0530 on 3 May, bleeding from the colostomy was again noted. Plasma was started soon thereafter. Examination at 0830 showed marked pallor; no air hunger; blood pressure 80/55; and a pulse of 92, with all the evidence of impending severe shock. Chest

wounds were well healed. The colostomy in the left upper quadrant had exuded about one pint of dark red, clotted blood. The abdomen was not distended. There were no signs of fluid in the abdomen. A presumptive diagnosis was made of bleeding peptic ulcer. It was the opinion of the medical consultant that he should receive conservative ulcer treatment in the form of milk and cream, 60 drops a minute by tube. Whole blood transfusion was given slowly, 40 to 60 drops per minute, increasing the flow when the systolic blood pressure fell below 80 mm. mercury. At 1030 the same morning, the blood pressure was 98/40; the dressing was again saturated with clotted dark red blood. At this time he vomited explosively about 400 cc. of fluid, the last of which contained some unclotted blood. Blood pressure shortly afterward was 80/40. The possibility of thrombosis of the splenic vein was now also considered, with resulting esophageal and gastric varices. Later the same morning he vomited twice about three ounces of bright red blood. At 1215 the blood pressure had dropped below 80, and the pulse had risen to 108. A Levine tube was passed and the half milk and half cream mixture was run in slowly. A half hour later he vomited some food and dark colored blood. During the next hours, the blood pressure dropped ten more points, and the blood transfusion was stepped-up to 120 drops per minute. Shortly afterward he again vomited blood and food; the tube feeding was stopped. Oxygen by nasal catheter was begun. Blood pressure was 75/40, with a pulse of 124.

During the first 24 hours the patient received 14 pints of blood and one pint of plasma. He also received morphine in small amounts, 1 Gm. of calcium gluconate in distilled water, 500 mg. of vitamin C, 3.2 mg. of vitamin K, and 150 mg. of vitamin B-1. The blood was run in slowly, varying the speed of drop in an attempt to maintain his systolic pressure at approximately 80 mm. of mercury. A medical officer was in constant attendance to regulate the drop speed in accordance with blood pressure readings. By 0630 of the morning of 4 May, 1945 the blood pressure, in spite of close supervision, was 60/40, with a pulse of 156. The patient had had 26 copious stools from the colostomy, which consisted of little else than clotted blood. It was felt at the this time that the patient was slowly going downhill in spite of the administration of blood and fluids. The hemorrhage was continuing uninterrupted; it was believed that the bleeding must be from a large blood vessel. The problem then arose whether further conservative treatment was indicated, with the hope that the bleeding would abate, or whether an exploratory celiotomy should be performed. It was the opinion that any exploration would be hazardous, and the chances of finding the bleeding point if it should be in the area of the previously lacerated bowel not too good in view of the previous surgery. However, because the patient's condition seemed slowly becoming worse, in spite of extensive supportive measures for the past 26 hours, exploration was decided upon. The first choice of the site of the bleeding still continued to be the duodenum. Large amounts of blood in massive doses were to be given immediately preoperatively.

The patient was slowly transported by ambulance from the holding wards to the operating room. On arrival at the operating room, he seemed somewhat less pale, and claimed that he felt better. The blood pressure at that time was 100/62; pulse 120. In view of the slight improvement it seemed best to temporize to see if the bleeding would stop without exploration. During the remainder of the day he continued to improve; slowly receiving five additional pints of blood, bringing to 19 the total transfusions administered in 40 hours. In the evening his blood pressure was 125/70; and his pulse had dropped to 106.

The morning of 5 May he had a temperature of 105° F.; urine was negative. The medical consultant believed a pericardial friction rub was present and thought the findings might be on the basis of an azotemia. However, the N.P.N. was found to be 40. During the day he progressed satisfactorily. There was one bloody movement from the colostomy during the day, but no evidence of further bleeding. Urinary output was good during the 24-hour period. The blood values had been quite severely affected by the bleeding, as an analysis showed the specific gravity to be 1.044, plasma specific gravity 1.020, plasma protein 4.4 Gm. %, hematocrit 32%, hemoglobin 10.8 Gm. Two days later, on the 7th of May,

the R.B.C. was found to be 3,720,000, with a hemoglobin of 13.5 Gm., blood sp. gr. 1.053, plasma sp. gr. 1,024 hematocrit 40, plasma protein 5.85 Gm. %; the twenty-first pint of blood was administered. Following this transfusion he had a slight urticarious reaction. On the 8th of May at 1330, bloody stool was again noticed from the colostomy followed by several others in quick succession. These were quite copious and consisted almost entirely of dark black blood which was not clotted. Blood pressure dropped to 100/68; the pulse remaining at 72. The next morning, the 9th of May, the blood pressure was 100/68; pulse 66. His blood picture was approaching normal levels, with a specific gravity of 1.054, plasma sp. gr. of 1.026, plasma protein 6.5 Gm. %, hematocrit 40, hemoglobin 13.7 Gm. He had had only one bloody stool during the night. At 1445 on this day however he again began to bleed profusely through the colostomy. The pulse became weak, 110 per min., and the blood pressure dropped to 80/50. Blood was again started in both arms, running at 80 drops per minute; after one hour of this treatment the blood pressure was still 84/60. Several hours later he looked somewhat better although still having copious bloody stools. During this day he received four pints of blood, which totaled 25 pints administered since admission. Late that day his color was fairly good, he was hungry and seemed somewhat improved. It was believed that conservative therapy still was indicated in the hope that this might prove to be the last episode of bleeding.

FIG. 1.—Showing bleeding point in resected bowel.

On the morning of 10 May, however, bleeding again started in profuse amounts, with multiple stools of pure dark blood. Again, the patient became shocked, with continuing massive loss of blood from the colostomy. The bleeding continued well into the afternoon unabated. The patient definitely seemed to be slipping out of control, although blood was being run in rapidly in an attempt to maintain the blood pressure just above shock level, and not fast enough to increase the bleeding. Exploration of the colostomy with a finger did not reveal bleeding at or near the stoma. While blood was being run into three different veins in preparation for surgery, the patient had a severe shaking chill which lasted about 15 minutes. This was thought to be due to the temperature of the blood, which had been kept in the icebox and was therefore cold, when it was introduced into the multiple veins. Later in the afternoon, after 2,000 cc. of blood had been run in rapidly, he was taken to the operating room for exploration.

An upper right paramedian incision was infiltrated with 1% novocaine, and gas-oxygen supplementary anesthesia was used. On opening the peritoneal cavity there was no free blood or fluid found. Examination showed that both the large bowel and the small bowel contained blood, as indicated by its abnormal dark-bluish color. A high loop of jejunum was found adherent in the left gutter. This loop also contained blood. It was thought that this portion of the bowel was probably the site of the previous perforations. Because the duodenum was still considered the most likely site of the bleeding a longitudinal incision was made in it about two inches distal to the pylorus. When the duodenum was opened at this point, no free blood was found in the lumen, and there was no evidence of blood coming down from the stomach. A suction tip was introduced into the stomach; gastric

contents and gas were removed, but no free blood was found. A finger was then introduced distally in the duodenum downward and to the left across the midline. No free blood or clots were encountered. The duodenum was then closed in layers transversely. The previously described loop of jejunum which was adherent in the left upper quadrant was distended with several mushy clots; it was freed from the area of the previous operation. At a point about 12 inches distal to the ligament of Treitz the points of closure of four perforations were identified. Here, the jejunum was opened for a distance of two inches at its antimesenteric border. Many clots and also free bright blood were encountered. On removing these clots a mucosal defect was found in the site of one of the closed perforations (Fig. 1). This defect was about 2 mm. in diameter. A thrombus was protruding from it for a distance of 0.5 cm., and around the thrombus arterial blood was pumping into the lumen of the bowel. On removing the clot from the bleeding point extensive free arterial bleeding occurred. This area was about 1.5 cm. from the mesenteric border of the bowel. On examining the mesentery immediately beneath it, a good-sized artery could be identified. This vessel led directly up to the bleeding area in the closed perforation. The eroded area together with about one-half inch of surrounding bowel was excised. After excision of the piece of jejunum, a large artery could again be seen to have led directly into the site of erosion. This vessel was controlled by passing one cotton suture beneath it in the mesentery just before the vessel entered the bowel, which completely controlled the bleeding in the cut edge. Bowel continuity was then reëstablished by an end-to-end anastomosis. Sulfanilamide was powdered into the area of the opened duodenum and the jejunal anastomosis. One thousand cubic centimeters of blood had been run in during the procedure. While in the operating room the blood pressure dropped to as low as 92/50, respirations 36; and pulse 180. The operating time was slightly less than two hours. By the end of the operation the blood pressure had risen to 110/60; and the pulse had slowed to 130.

The patient made steady improvement postoperatively. He was administered additional blood slowly over the next 24 hours, together with intravenous infusions of saline and distilled water containing vitamins and calcium. On the second day postoperative, he received his last transfusion, the thirty-fifth in the series. A blood count taken at this time showed the red cells to be 3,900,000, hemoglobin 90%. Final blood analysis two weeks after the operation showed blood specific gravity to be 1.059, plasma specific gravity 1.025, plasma protein 7.15 Gm. %, hematocrit 45, hemoglobin 15.3 Gm.

SUMMARY

(1) A case is reported of massive hemorrhage from the gastro-intestinal tract at the site of previous traumatic wounds of the bowel.

(2) Twenty-two days after injury, bleeding occurred in the area of one of the closed perforations and two days later it became massive.

(3) During the first 24 hours of this bleeding it was necessary to administer 14,500 cc. blood transfusions to replace lost blood.

(4) Recurrent bleeding in large amounts continued during the next seven days, which necessitated the administration of a total of 35 pints of blood, together with other fluids.

(5) Bleeding from such a previously sutured perforation is unusual, but should be kept in mind in patients with abdominal trauma.

NEUROFIBROMA OF THE SMALL INTESTINE WITH MASSIVE HEMORRHAGE*

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BENIGN TUMORS of the small intestine are comparatively rare. This is particularly true when one excludes growths arising from the ampulla of Vater and the ileocecal region. They may occur at any age, and are more frequent in males than in females, in proportion of two to one.

The most common benign tumors are lipomas, adenomas, hemangiomas, pancreatic rests, cysts and fibromas. The fibromas are the most rare of all tumors in the small intestine. Raiford[7] reported 21 cases, one of which was a fibroma; Rankin[9] reported 24 cases, six of which were fibromas; Morison[6] reported 21 cases of tumors of the small intestine, one of which was a pedunculated subserous fibroma; and Collins[2] recently reported a neurofibroma, and gave a description of the pathologic classification of these growths.

Herewith are reported two cases of neurofibroma of the small intestine that were pedunculated in type and caused very severe intestinal hemorrhage.

Fibromas arise from connective tissue of the small intestine. They may be subserous, intermuscular, intra- or extraluminal, or they may be attached to the serosa and be pedunculated and not encroach into the lumen of the bowel. They may be pea-sized or they may be very large.

The fibroma is thought to arise from connective tissue elements of the small intestine, probably from the submucosa, or they may arise from connective tissue elements of the nerve or venous plexis, or from the muscular wall of the bowel. It is because of the various tissue elements comprising the tumors that the growths have been so variously named; hence, the tumor may be described as a fibroma, fibrosarcoma, fibroblastoma, leiomyoma, or many other names. The tumors are usually encapsulated. In most instances they are benign, although a low order of malignancy has been noted.

Fibromas of the small intestine may not produce any symptoms during life. The existence of the tumor may be found at autopsy. When symptoms are observed, vague intestinal discomfort is sometimes complained of. In most instances reported the symptoms of intussusception or volvulus of the intestine has led to the discovery of the growth at operation. Severe intestinal bleeding may also result because of the presence of these tumors but in most instances the tumor or tumors were found on abdominal exploration, since the presence of an intestinal tumor was not suspected. The production of a volvulus by these growths is easily seen because of their pedunculated shape and because the growth, as a rule, is at the antimesenteric border.

* Modified from a paper presented before the Chicago Surgical Society, December 8, 1944.

The severe bleeding which the tumor causes is more difficult of explanation. In the two patients, whose histories are herewith reported, intestinal bleeding had been very serious and at operation the tumors were found to be of a pedunculated type with only a small portion of the tumor within the lumen of the intestine. The portion of the tumor within the intestine was only partially covered by mucosa, and there was no ulceration or erosion of the mucosa anywhere about the site of the growth. The tumors did not appear highly vascular and there were no large areas of degeneration to be seen.

The significant fact in the histories of both of these patients was that they had noted at times bright red blood in their stools.

FIG. 1.—Photograph of neurofibroma taken before removal.

CASE REPORTS

Case No. 1.—S. J., male, age 37, was admitted to the Presbyterian Hospital August 26, 1942. Black tarry stools had first appeared in October, 1941, lasting about three weeks, accompanied with weakness. Under treatment for anemia, he improved. Diarrhea with tarry stools occurring in attacks averaging about three days in duration occurred in February, April, June and August of 1942. There had been occasional burning epigastric distress without relation to the ingestion of food but he was relieved by the use of soda bicarbonate.

Physical examination was essentially negative. The erythrocyte count was 4,800,000, and the hemoglobin concentration 10.25 Gm. %. Fluoroscopic examination of the stomach disclosed spasm and deformity of the duodenal cap, without a definite crater. Gastric analysis was within normal limits. Ulcer management was followed by improvement, but in February, 1943 the stools again became tarry, and in addition there was bright red blood. He was readmitted March 28, 1943 for exploratory celiotomy. Preoperatively, his condition was excellent; the hemoglobin concentration being 14 Gm. %; and the erythrocyte count 4,500,000.

Operation.—At celiotomy, the stomach and duodenum appeared normal, but the duodenum was opened because of the history of intestinal bleeding. This was closed after nothing unusual was observed. About 17 inches from the ileocecal valve a hard tumor was found on the antimesenteric border of the ileum, mushroom in shape, dusky red, and solid It extended into the lumen for about one-quarter of an inch, and was covered with normal lining, although the surrounding mucosa was discolored as from old hemorrhage. The bowel was circumcised about the tumor, which was removed, and the opening sutured transversely, using three layers of catgut. The abdominal wound was closed without drainage. Recovery was uneventful; and no known recurrence of the bleeding has occurred to date.

Pathologic Examination.—Gross: The tumor after removal disclosed it to be in the shape of a mushroom, the larger portion of which was about 35 mm. in greatest diameter and corresponded to the extramural portion. The smaller portion, about 20 mm. in greatest diameter, represented the intramural and intraluminal portion, with a total thickness of about 30 mm. The dome of the smaller portion was covered with mucous membrane and that of the larger portion by a transparent serosa. The mucosa was intact except for a

minute dimple on the summit of the dome; into which a probe could be passed about 2 mm. On section, the neoplastic tissue was firm, pale tan-gray-white, fibrous in character, and with a slight tendency to interlacing. A few small hemorrhages were observed in the outer portion beneath the serosa but none near the mucosa. The possibility exists that the hemorrhages occurred as the result of manipulation during surgical removal (Figs. 1, 2 and 3).

Microscopic Examination.—Sections taken to include the entire tumor through one plane, stained with hematoxylin and eosin, *etc.*, disclosed the muscularis to be completely interrupted by the extension of the tumor through it, stretching of the mucosa and submucosa over the dome of the smaller portion, stretching of the serosa over the greater portion, and extension of a few of the muscle bundles of the muscularis superficially into the adjacent portions of the tumor. In addition, there were interlacing bundles of parallel cells, the cells having long slender nuclei with sparse cytoplasm separated by spare stroma, the absence of mitotic figures, a sparse scattering of lymphocytes throughout and slight hyalinization in the subserosal portion. Vascularity was moderate, hemorrhages were sparse near the subserosal margin but were absent near the mucosa, corresponding to the gross observations, and necrosis was insignificant. A comparison of the neoplastic cells with those of the muscle cells of the muscularis disclosed the former to be larger and darker staining. *Pathologic Diagnosis.*—Neurofibroma, with a questionable origin from the muscularis of the small intestine.

FIG. 2.—Neurofibroma of the ileum.

Case No. 2.—A. M., female, married, age 33, was admitted to the Presbyterian Hospital, April 7, 1943, because of severe diarrhea, accompanied with tarry stools. Previously tarry stools with diarrhea, once with bright red blood, had been irregularly recurrent since the first attack in 1940, recurring in 1942 and in March and April of 1943. Following the last attack she fainted, and there was also nausea and vomiting, without blood in the emesis.

On admission, she was in mild shock, without abdominal pain or distress, and there had been no history of any abdominal or epigastric pain or distress, except for cramps with the diarrhea in 1942. The erythrocyte count was 2,600,000, and the concentration of hemoglobin 56 per cent. Blood pressure 90/60. A tentative diagnosis of peptic ulcer, with bleeding, was made and ulcer management was begun. In the first 24 hours after admission 1,500 cc. of whole blood were administered. The diarrhea with tarry stools and clots of blood continued. Thirty-six transfusions of blood, totaling 20 liters, were given during the first week. A short time following each transfusion, from 250 to 500 cc. of a dark, bloody stool was passed, with a subsequent drop in the blood pressure and a corresponding decreased erythrocyte count and hemoglobin value. Hykinone and calcium gluconate were also given. The bleeding suddenly stopped on the eighth day. The stools became free of occult blood within four days, and improvement was steady. She received another liter of blood; and upon discharge the erythrocyte count was 4,100,000, and the hemoglobin concentration 9.2 Gm. %. Proctoscopic and fluoroscopic examinations of the colon failed to substantiate the ideas of a polypus of the colon or a bleeding Meckel's diverticulum. The possibility of a duodenal ulcer was suggested by the fluoroscopic observation on only one occasion of a spasm deformity of the duodenum.

The patient was readmitted, February 3, 1944, because of the passage of tarry stools, and the performance of an exploratory celiotomy was decided upon. The hemoglobin concentration was 11.5 Gm. %; and her condition good.

Operation.—A right upper paramedian incision was made, and examination of the stomach and duodenum was negative to external inspection and palpation. About five feet from the ileocecal valve a relatively large mushroom-like, firm, circumscribed tumor extending into the lumen for about one-quarter of an inch was observed on the antimesenteric border of the ileum. The lining over the tumor appeared intact but stained with blood, and a large mesenteric vein was attached to one side. The lymph nodes in the adjacent portion of mesentery were not enlarged. The intestine was circumcised around the tumor and the opening closed in the transverse axis with three layers of sutures. The abdomen was closed without drainage. Recovery was uneventful; and there has been no known recurrence of bleeding to date.

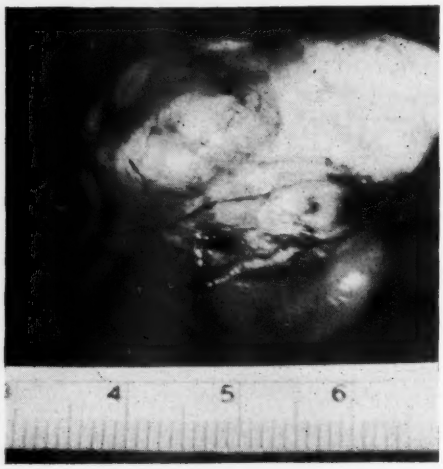

FIG. 3.—Neurofibroma of the ileum showing cut-section.

Pathologic Examination.—Gross: The specimen after removal disclosed it to be roughly mushroom in shape, up to 5 cm. in greatest diameter. It was covered with an intact mucous membrane, at the smaller end, while the larger portion had a serosal covering. On section, the bulk of the tissue was fibrous and a pale yellow-gray. Small cystic spaces resulted in a more spongy character of the zone beneath the mucosa, and this was bluish-red.

Microscopic Examination.—Two pieces, one to include the serosa and subjacent portion and the other the mucosa and subjacent portion, stained with hemotoxylin and eosin, Foot preparations for reticulum and van Gieson preparations, disclosed the general character of the tumor to be one of interlacing bundles of parallel cells separated by a relatively sparse collagenous and reticular stroma. The neoplastic cells were abundant, with elongated fusiform nuclei rounded at their ends in longitudinal section, and polymorphic, small and dark on transverse section. Mitotic figures were not observed. In the subserosal portion there was a thin, fibrous capsule subjacent to which was a partial replacement of the neoplastic cells by a sparsely fibrinous edema fluid, leaving islands of cells arranged about blood vessels, the walls of which were thin and hyalinized. Lymphocytes were sparse. *Pathologic Diagnosis:* Neurofibroma of the wall of the small intestine.

DISCUSSION.—Clinically, each of the patients had relatively long-standing recurrent episodes of dark tarry stools which at times also contained bright red blood, in the presence of otherwise apparently good health. The abdominal distress in Case 2 was presumably associated with the diarrhea incident to the bleeding. In each case suspicion of duodenal ulcer existed and the ulcer management instituted was followed by recurrence of the bleeding. Conservative treatment in Case 2 during the episode of prolonged bleeding ultimately was followed by surgical intervention. Each patient recovered uneventfully without subsequent bleeding.

Anatomically, the lesions were alike in their fundamental character, shape, relation to the wall (antimesenteric, and both intra- and extraluminal), general location in the ileum (one, one and one-half feet and the other five feet from the ileocecal valve), and in their association with intestinal bleeding. They

differed chiefly in their size, and the larger had undergone slightly more advanced retrogressive change and hemorrhage within the tumor. In neither was the bleeding point identified although a minute defect on the summit of the mucosa of the smaller tumor (Case 1), perhaps associated with pressure atrophy, may have been of significance in the bleeding. Such hemorrhage as was observed was in the subserosal portion in each tumor away from the mucosa and may have been due to handling during removal. The more massive bleeding occurred with the larger tumor (Case 2). The changes of necrosis and inflammation were comparatively slight, and the inflammation observed was subacute exudative in type.

The significant fact in both of these patients was the history of recurring attacks of tarry stools and the observance by them of the occasional presence of bright red blood in the stool. The occurrence of the latter was suggestive of some lesion in the small intestine like a Meckel's diverticulum.

General Discussion.—The prefix "neuro" used in the term neurofibroma implies a special origin, or character, to what is otherwise an essentially fibrous type of neoplasm. A study of the literature discloses some confusion in terminology of these tumors. The cell concerned is considered to be either from the sheath cell (Schwann cell) about a nerve fiber or the fibroblast of the delicate framework of connective tissue supporting the nerve fiber or fibers. The cells that compose these neurofibromas appear and act more like fibroblasts than otherwise, their presence being associated with the production of fibrils of reticulum and relatively sparse fibrils of collagen. These cells have also a resemblance to smooth muscle cells, not only individually but in their tendency to form interlacing bundles of parallel cells. Thus, there is a group of similar neoplasms of three different types, the fibroma (arising from the ordinary fibroblasts); the neurofibroma (arising from a special fibroblast-like cell associated with nerve fibers); and the leiomyoma or leiomyofibroma (arising from smooth muscle cells alone or together with the ordinary fibroblasts). In the ordinary surgical pathologic examination there is no difficulty in distinguishing the fibroma from the other two, since in the fibroma there is usually no particular arrangement of cells in relation one to another and, except in the more cellular types, collagen is usually abundant. The neurofibroma and leiomyoma are not so easily separated, although definite criteria have been established for their microscopic diagnosis. Myofibrils, when demonstrated, allow a conclusive diagnosis of a leiomyoma. Their demonstration in the ordinary handling of surgical material appears to be difficult. Another feature, chiefly presumptive, is the relatively greater abundance of the cytoplasm, especially as compared to the nucleus both in longitudinal and cross-sections of the individual cells, in the leiomyoma. Interlacing of bundles of parallel cells is common both to the neurofibroma and leiomyoma. However, the two may be distinguished by a feature of the neurofibroma, which is believed to be fairly characteristic. This is a tendency to palisading of the nuclei, interpreted as due to division of the cells in their long axes. The degree of palisading in different tumors varies,

and there exist subclassifications based upon these variations. In the opinion of one of us, it is believed that all degrees of interlacing and of palisading may occur and that the variations do not represent a basic character justifying the division of the neurofibromas, in general, into groups of distinct entities. It is suggested that the differences in the patterns microscopically, for example, between a subcutaneous neurofibroma and an acoustic neurinoma, may depend upon the size and location of the nerve fibers concerned. Incidentally, it is not essential to the diagnosis to demonstrate an association of such a tumor with nerve fibers and the absence of such an association should not occasion doubt as to the diagnosis.

The demonstration of the point of origin of any particular tumor, as for example in the two cases reported, it is often impossible because of alterations resulting from the growth and size of the tumor when it makes itself clinically or otherwise apparent. Theoretically, they are believed to arise in association with nerve fibers wherever they may exist outside the central nervous system. In the small intestine these fibers occur throughout the wall, although they are most numerous in the two plexuses of the submucosa and muscular layers, respectively.

Grossly, a neurofibroma in the small intestine is an encapsulated tumor of variable size, slow in growth, and will produce symptoms depending upon the level at which it occurs, the degree to which it extends into the lumen and its susceptibility to hemorrhage.

Surgical Significance.—Eight correlations between the character of the neurofibroma of the intestine and their surgical significance are listed below:

1. They may be classed with the larger group of benign tumors, including adenoma, lipoma, *etc.*

2. Benign tumors are infrequent in the small intestine, so are not likely to be considered in a differential diagnosis. Malignant tumors of the small intestine, infrequent percentagewise, are numerically as frequent, or more so, than benign tumors.

3. Since benign tumors have been observed most frequently in the ileum and duodenum, this suggests that during an exploratory celiotomy these portions of the small intestine be examined first. In the two cases reported the tumors were found without difficulty.

4. At any one level of the intestine such tumors may occur at any point on the circumference, so as to be either antimesenteric, as in the cases reported, or to extend into the mesentery. If pedunculated, there exists predisposition to intussusception, with acute obstruction, in a patient previously well. The common cause of intussusception in an adult is a benign tumor. The existence of a pedicle will allow ready removal of the tumor, or natural processes may result in spontaneous amputation with the possibility of obstruction at some lower level.

5. The circumscribed and encapsulated character of a neurofibroma allows its ready and complete removal, a circumstance which may account for the absence of reported recurrence in the literature examined. This lack of recur-

rence is in contrast to that which may follow the removal of similar tumors in such locations as the retroperitoneal or subcutaneous tissues.

6. At exploration, the procedure of choice will be indicated by the circumscribed, somewhat mobile character of the lesion unassociated with adhesions in contrast to the changes associated with a malignant tumor. With the latter there is a common tendency to a napkin-ring type of constrictive obstruction, and extension of the neoplasm, although not necessarily present, may exist either directly into the adjacent structures with or without adhesions or to the adjacent mesenteric lymph nodes. The presence of adhesions is suggestive of either an inflammatory or a malignant neoplastic process.

7. The tendency to bleeding, which is reported as often pronounced with benign tumors of the duodenum, is presumably associated with several factors such as the vascularity of the mucosa, vascularity of the tumor, changes in the lining, such as pressure atrophy or ulceration, or ischemic necrosis of the tumor. In the two cases reported such changes were observed in a degree not corresponding to the volume of bleeding. Predisposition to hemorrhage occurs with the disseminated focal necrosis incident to scattered thrombi in the small vessels. Other factors may be involved and in this respect one may recall the common tendency to uterine bleeding with leiomyoma of the uterus where, of course, there is a recognized endocrine influence upon the endometrium.

8. Exclusive of other factors, the prognosis from the standpoint of the existence of a neoplasm is favorable. In the literature examined no recurrences have been noted.

SUMMARY

Two cases, each of persons with a neurofibroma of the small intestine, in which recurrent intestinal bleeding was the chief symptom and diagnostic problem are reported, with discussions of the cases, of the character, diagnosis and terminology of the entity neurofibroma and of eight considerations of surgical value. In patients with severe intestinal hemorrhage, especially when bright red blood appears in the stool and in whom the etiologic factor is doubtful, the possibility of the existence of a benign tumor of the small intestine should be considered and a search made for its presence.

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ADENOLYMPHOMA OF THE PAROTID AND SUBMAXILLARY SALIVARY GLANDS

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TUMORS composed of a combination of epithelial and lymphoid tissue, arising in or near the parotid and, occasionally, the submaxillary salivary glands, have been reported with increasing frequency. The terminology of these tumors is confused by the fact that they have been reported under a number of different names, of which the following may be enumerated: Papillary cystadenoma lymphomatosum, cystadenoma lymphomatosum, adenolymphoma, papillary adenolymphoma, papillary cystadenoma in lymph glands, branchiogenic cystadenolymphoma, branchiogenic adenoma, cylindrocellular branchiogenic adenoma, onkocytoma and Warthin's tumor. This varied nomenclature is, in part, a reflection of the numerous attempts that have been made to account for their origin. From a review of the literature and a study of the cases presented below, it is evident that not all tumors having this same fundamental structure are identical in either histologic pattern or clinical behavior. Thus, a group of tumors exists and it is the purpose of this communication to attempt to clarify the nomenclature by presenting a working classification based on morphology and clinical behavior. Four new cases are presented, one of which is malignant.

BENIGN ADENOLYMPHOMA

As suggested by Klemperer,[1] adenolymphoma has been retained as a general term to indicate any tumor of the salivary glands composed of a combination of epithelial and lymphoid tissue whether benign or malignant. The terms papillary cystadenoma lymphomatosum and cystadenoma lymphomatosum have been used to indicate papillary and nonpapillary variations of the same tumor. A closely related and possibly identical tumor has been designated adenoma lymphomatosum.

CASE REPORTS

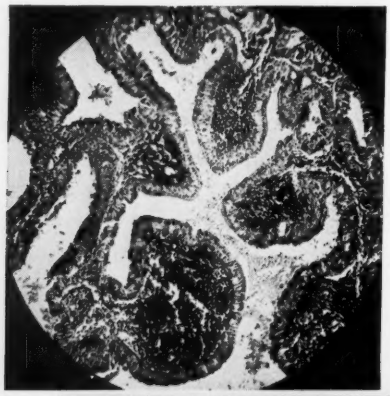
Case 1.—A white male, age 30, was admitted to the Framingham Union Hospital, October 29, 1944, complaining of a tumor of the right parotid region which had been present for approximately one year. For several months there seemed to be some variation in size, and the possibility of an intermittent obstruction of the parotid duct was at one time entertained.

Physical examination revealed no abnormalities except for a tumor 2.5 cm. in diameter, in the right parotid region near the angle of the mandible. It was well-encapsulated, fixed to the underlying tissues but not attached to the overlying skin. The regional lymph nodes were not enlarged.

At operation, the tumor was easily removed from its bed, which lay in the substance of the parotid gland. The postoperative course was uneventful, and there has been no recurrence to date.

The specimen measured 5 x 2 x 1 cm. and was encased by a thin, transparent capsule through which the purple-brown of the underlying tissue could be seen. The surface was smooth in places, slightly furrowed and lobulated in others. The consistency varied from firm in some areas, to soft and fluctuant in others. The cut surface was granular and pitted by tiny cysts from which a small amount of viscid, brown fluid was expressed.

FIG. 1



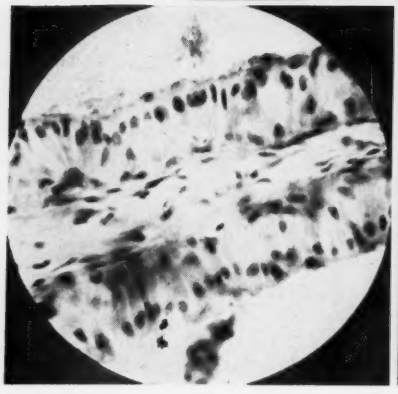


FIG. 2

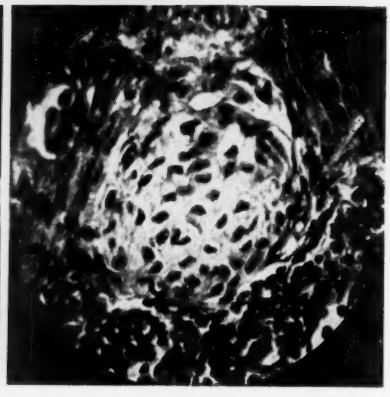


FIG. 3

FIG. 1.—Case 1: Papillary formations composed of epithelial cells lying upon a core of lymphoid tissue. Note germinal centers.

FIG. 2.—Case 1: From the same field as Figure 1, at higher magnification, showing the tall columnar, secretory type of epithelial lining, chiefly disposed in a single layer of regularly aligned cells.

FIG. 3.—Case 1: Portion of papilla displaying concentric arrangement and flattening of epithelial cells, resembling "cell nest" of epidermoid tumor (pseudometaplasia).

Microscopic study showed papillary structures composed of an external layer of epithelial cells lying on a lymphoid stroma (Fig. 1). The epithelial lining consisted of a single row of tall columnar, evenly aligned, epithelial cells, resting on a well defined basement membrane (Fig. 2). These cells had abundant, finely granular, eosinophilic cytoplasm and large, vesicular nuclei which varied from spherical to elongated in shape. A thin layer of amorphous, eosinophilic material, homogeneously distributed on the free surface, in places resembled cilia. No true cilia were found. The single-layered epithelial lining alternated in places with areas where the cells showed overlapping and pseudostrati-

fication. In the latter areas, because of reciprocal compression, the cells varied from low cuboidal- to club-shaped, in some areas having a flattened appearance which made them resemble squamous cells (Fig. 3). These flattened cells showed a tendency to concentric arrangement, resulting in nests of cells with elongated cellular bodies and flattened- or comma-shaped nuclei. Keratin granules or other patterns of cell cornification were not demonstrated in these areas, and it was evident that they resulted from histologic accommodation and not from cell metaplasia.

The stroma was abundant and consisted of true lymphoid tissue containing fully-developed and actively functioning germinal centers. In spite of the abundance of the stroma, there was no evidence of compression or distortion of the epithelial elements. Very

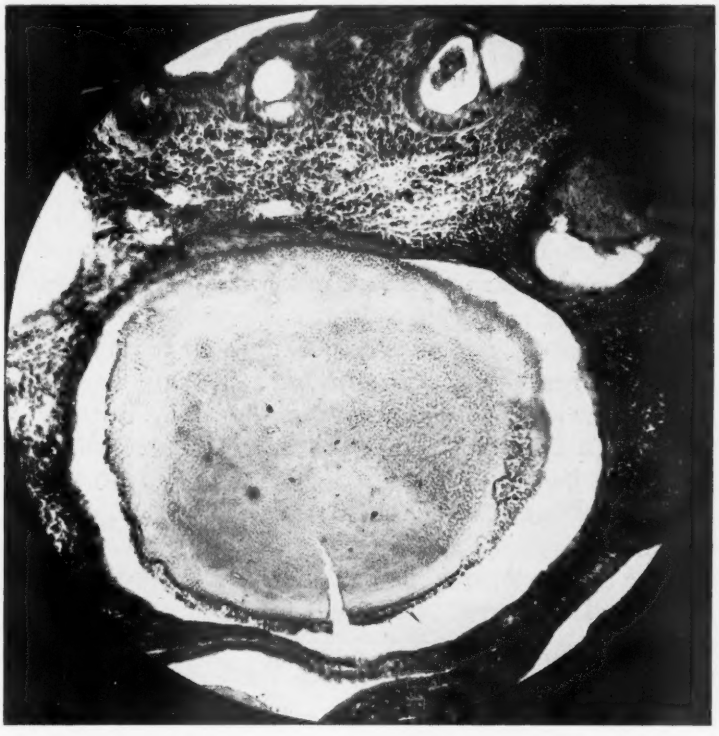


FIG. 4.—Case 3: A purely cystic tumor. Except for lack of papillary projections the structure is similar to Cases 1 and 2.

few, thin, connective tissue fibers were recognized in the cores of the papillae, and the blood vessels were chiefly thin-walled, congested capillaries. No salivary gland tissue was found in the tumor, although a few groups of such cells were attached to the capsule.

The cystic spaces were empty in some areas, while in others an amorphous, eosinophilic material containing pyknotic nuclei and cellular débris was noted.

Case 2.*—A white male, age 57, was admitted to the Massachusetts Memorial Hospitals, May 8, 1945, complaining of a tumor on the left side of the neck of eight months' duration. Examination showed a firm mass, 4 x 2 cm. in diameter, underlying the angle of mandible. The tumor was movable on the underlying tissue and was not attached to the overlying skin.

At operation, the tumor was found to be completely covered with parotid tissue but was easily enucleated from its bed. The postoperative convalescence was uneventful.

* We are indebted to Dr. Thomas J. Anglem for permission to report this case.

Microscopic examination showed the structure to be identical with that of Case I. The papillary formations consisted of a core of lymphoid tissue, containing germinal centers, on which rested the same type of tall, columnar, pseudostratified epithelium. There was no evidence of ciliation.

Case 3.—A white female, age 70, was admitted to the Massachusetts Memorial Hospitals, May 10, 1945, complaining of a slowly enlarging mass in the left parotid region of two years' duration. Examination showed the mass to be well-encapsulated, nontender, and approximately 3 cm. in diameter. It lay anterior to the lobe of the ear, was not attached to the overlying skin but was somewhat fixed to the underlying parotid gland.

At operation, the tumor was found to be well-encapsulated and was shelled out of its bed without difficulty.

Microscopic examination (Fig. 4) showed large and small cystic spaces filled with dense, amorphous, eosinophilic material. The lining epithelium resembled that of the preceding cases, with no evidence of anaplasia or abnormal mitotic activity. The stroma consisted of a fine, fibrous reticulum densely infiltrated with mature lymphocytes. Many lymphoid follicles were noted. An outstanding characteristic was the complete absence of papillary processes projecting into the cystic spaces.

Incidence.—In 1898, Hildebrandt[2] first reported a similar tumor in a 41-year-old male. This case was mentioned in a series of 20 cases of cysts and fistulae of the neck, all considered to be branchiogenic in origin. It was not until 1910 that Albrecht and Arzt[3] described two cases which they believed to represent a specific tumor type. A review of the literature indicates that similar tumors have been reported with increasing frequency. In 1929, Warthin[4] reported two typical cases. He emphasized their rarity by stating that these were the only cases he had seen in a series of over 700 mixed tumors of the parotid, and over 500 branchial cysts. By 1932, Jaffé[5] was able to find reports of 21 cases. Harris[6] found 43 cases up to 1937. In 1942, Plaut[7] found 48 cases in the literature and reported 16 new cases of typical papillary cystadenoma lymphomatosum. He reported three additional cases which differed slightly from the usual histologic picture in that the epithelium consisted of low cylindrical cells with vesicular nuclei. Between the bases of these were small cuboidal cells, irregularly spaced. This epithelium lined small cystic spaces and was embedded in a stroma of lymphoid tissue containing germinal centers. A microscopically similar tumor has been reported by Fine.[8] Subsequent reports by Robinson and Harless,[9] Lederman,[10] Ackerman,[11] Ramage, *et al.*,[12] and Martin and Ehrlich,[13] together with the above cases, brings the total reported to date to 94.

Table I shows the age incidence by decades in the 92 cases in which the age is reported. Seventy cases, or 76 per cent, are in the fifth, sixth and seventh decades. Extremes of age are a child of 2.5 years, reported by Stöhr and Risak,[14] and a man of 92, reported by Carmichael, Davie and Stewart.[15] Of the 92 cases, 73 are reported in males, 17 in females and in 2 cases the sex is not stated. This is a ratio of 4.5 males to 1 female.

Histogenesis.—No completely satisfactory explanation for the occurrence of these tumors has been suggested. Of the several theories proposed, the following are the most important:

The *branchiogenic theory* was first suggested by Hildebrandt, and has been favored by Ssobolew,[16] Ewing,[17] and others. These authors believed the tumors arose from the ectodermal portion of a branchial arch. The presence of large amounts of lymphoid tissue in branchial cysts, together with an embryonal type of epithelium, was the background of this hypothesis. The epithelial cells of the tumor have even been likened to the large, eosinophilic cells of the parathyroid gland.[13] Most modern authors agree that there is no convincing evidence for this hypothesis.

Kraissl and Stout,[18] after reviewing the work of Schulte, suggested that remnants of the *"orbital inclusion,"* a vestigial structure which, in some carnivora, gives rise to the orbital salivary gland, might give rise to the tumor. This theory attempted to account for the lymphoid tissue as well as the epithelium. However, the orbital inclusion has not been demonstrated in man.

TABLE I

AGE INCIDENCE

Age	Cases
1– 10	2
11– 20	3
21– 30	4
31– 40	6
41– 50	23
51– 60	25
61– 70	22
71– 80	6
81– 90	..
91–100	1
Total	92

Hamperl,[19] after reviewing the work of Schaffer and Zimmerman, suggests that these tumors may arise from specific cells which he terms *"onkocytes."* These cells are said to develop from both secreting cells and the lining of ducts, by an increase in size and a peculiar differentiation of the cytoplasm, which assumes a finely granular appearance. The nuclei are located near the lumen, are frequently indented and are rich in chromatin. Inasmuch as they are never found before the age of 20, and only rarely before the age of 30, they have been considered a product of advancing years. After the age of 70 they are nearly always present in both sexes. Jaffé accepts this hypothesis and suggests the term "onkocytoma."

There are a number of objections to the onkocyte theory. Harris has pointed out that typical tumors have been reported in children, whereas Hamperl did not find onkocytes before the age of 20. Furthermore, these tumors have been found in relation to the parotid gland, rarely in relation to the submaxillary gland, and nowhere else. Onkocytes have been found in all three of the salivary glands, in mucus glands of the tongue, floor of the mouth, uvula, pharynx, esophagus, trachea and elsewhere.[20] Finally, onkocytes have been found with equal frequency in both sexes while tumors occur considerably more frequently in men.

Albrecht and Arzt first suggested that these tumors might arise from rests of *heterotopic salivary gland tissue* situated in lymph nodes lying within the substance of, or adjacent to, the parotid salivary gland. This theory had its origin in the work of Neisse[21] who showed that in the 120-mm. fetus, there are numerous lymph nodes lying within the substance of the parotid. These nodes have diffuse outlines and salivary tubules are scattered freely within their substance. When condensation and capsule formation later take place and these areas of lymphatic tissue develop into the preparotid nodes, it "usually happens

that tubules are separated from the rest of the parotid."[22, 23] Neisse was able to demonstrate the presence of scattered acini, or whole lobules of salivary gland tissue in the periparotid nodes of newly born infants.

A careful study of six periparotid lymph nodes which we obtained from a new born infant dying of congenital heart disease, revealed similar structures. We are not certain that these are glandular in origin. It is possible that they are lymphatic sinuses lined by large, embryonal endothelial cells, which closely simulate low cuboidal epithelium. Further study of this point is desirable.

The chief objection to the glandular displacement theory, as pointed out by Martin and Ehrlich, is that conclusive evidence has not been presented to show that the lymphoid tissue in these tumors is actually part of a lymph node. An important consideration in this respect is the fact that lymph sinuses have not been described in any of the reported cases, nor were we able to demonstrate them in our cases.

Warthin concluded that the epithelium of the tumor was "precisely like that of part of the eustachian tube, which has a tall, stratified, ciliated, columnar epithelium, with many lymphoid follicles beneath the epithelium." He expressed the opinion that the tumor arises from a *heterotopia of mucus membrane from the pharyngeal entoderm,* representing either the upper respiratory tract or the eustachian tube. He described a polypoid tumor of the eustachian tube with an identical microscopic structure.

Warthin described the epithelium of his tumors as being ciliated. Wendel[24] also reported a case in which the epithelium was described as ciliated. All other authors have found nonciliated epithelium. A study of the illustrations in the presentations of these authors leads us to believe that true ciliation was not present, but, as in our cases, the free surface of the epithelium was covered with a thin layer of amorphous material which, in places, resembled cilia.

Harris has stressed the importance of ciliation, pointing out that while there is no convincing evidence that the tumors are of branchiogenic origin, the occurrence of ciliated cells would definitely indicate origin from a pharyngeal pouch. We should like to point out that lack of ciliation does not necessarily preclude the possibility of origin from a pharyngeal pouch or from heterotopic eustachian epithelium. It is well known that the degree of ciliation varies greatly in areas of normal ciliated epithelium. Thus, areas are encountered in which there is complete, or nearly complete, absence of cilia, immediately adjacent to areas that are heavily ciliated. Furthermore, ciliation is in some degree dependent on the functional necessity for cilia. For instance, in the fallopian tube, the degree of ciliation varies with the reproductive cycle. Obviously heterotopic epithelium giving rise to a tumor might be nonciliated regardless of its origin, and ciliation of tumor epithelium would be unlikely in any event, simply on the basis that the cilia could have no possible function.

We agree with Warthin that these tumors arise from epithelium and lymphoid tissue displaced from the pharyngeal entoderm or upper respiratory tract. The remarkable similarity between tumor epithelium and that lining the upper respiratory passages in the embryo is illustrated in Figures 5 and 6.

However, we do not agree with Warthin, and subsequent observers, that tumor and respiratory epithelium consists of two layers of cells, the outer cylindrical and the inner cuboidal. Careful study of many sections from the above cases, and of the published illustrations of other authors, leads us to believe that this appearance is due to pseudostratification. This being the basic pattern, deviations are to be expected in tumor growth. Among these deviations, concentrically arranged cell nests resembling the "pearls" of epidermoid tumors were frequently found in all of our cases. Similar changes, perhaps on a larger scale,

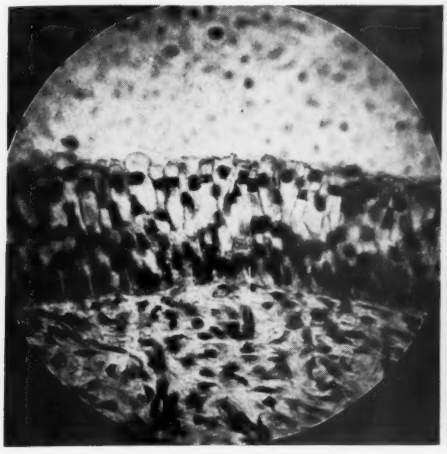


FIG. 5

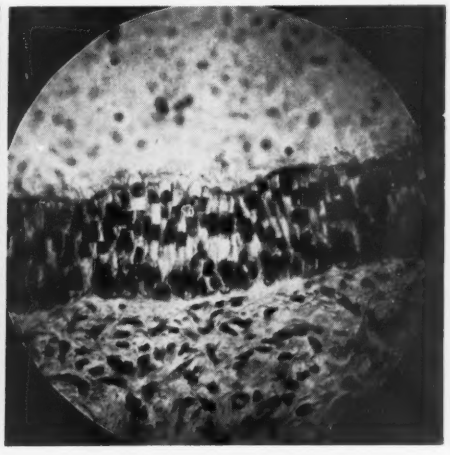


FIG. 6

FIG. 5.—Case 1: From a portion of papilla showing widespread pseudostratification of the nonciliated epithelial lining. Compare with Figure 6.

FIG. 6.—Mucosal lining of upper respiratory tract of embryo. Compare with Figure 5. (Slide loaned through the kindness of the Department of Anatomy of Harvard Medical School.)

were present in the second case reported by Ssobolew. In spite of the absence of mitotic figures and the lack of infiltrative power or metastatic involvement, he concluded, on the basis of these epithelial patterns, that a malignant change had occurred. A similar conclusion is certainly not justified in our cases.

Clinical Course.—These are slowly growing tumors, the duration before excision varying from a few months to over 30 years. Facial disfigurement is the common presenting complaint and the tumors are usually not painful or tender.

The mass is usually found near the angle of the mandible, or in the retromandibular area. Freshman and Kurland[25] reported such a tumor occurring at the anterior border of the superior portion of the sternomastoid muscle, and Wendel, Albrecht and Arzt and Spitznagel[26] reported tumors lying in relation to the submaxillary gland. Martin and Ehrlich believe the latter arose in relation to the tail of the parotid which, on its antero-inferior aspect, lies in relation to the submaxillary gland.

The tumors are about evenly divided between the right and left sides. Mar-

tin and Ehrlich report three cases with bilateral growths, in one of which multiple tumors occurred bilaterally. Ramage, Binnie and McCall also report a case with bilateral tumors, multiple on one side.

On clinical examination, the tumors are smooth in contour, thus, differing from the usual finding in mixed tumors of the parotid. They are moderately firm to fluctuant in consistency and, because of their invariable location near the surface of the gland, are movable to at least some degree.

Because of the obvious encapsulation and the presenting complaint, the diagnosis will usually not be made until the excised tumor is examined grossly and microscopically. Martin and Ehrlich found sialography of no great diagnostic aid. Aspiration biopsy was performed in 18 cases by the same authors. In only nine of these was a positive diagnosis made. In view of the difficulties encountered by the average pathologist in accurately interpreting slides made from aspirated material, there seems to be little place for this procedure.

Treatment.—The treatment of choice is surgical removal. Because the tumors are encapsulated and lie on or near the surface of the gland, this is usually accomplished without difficulty and with minimal danger to the branches of the facial nerve. Incomplete excision has been followed by recurrence in two tumors reported by Lederman and in one reported by Carmichael, Davie and Stewart. The latter recurred three years after excision and the recurrent tumor was not removed for an additional ten years. The histology of the original and recurrent tumors was the same except for some areas of "squamous metaplasia" (*vide supra*) in the recurrent tumor.[6]

The question of radiation therapy has been discussed by Martin and Ehrlich, who feel that the character of the lymphoid tissue, the presence of adenoid elements and cyst formation, do not augur well for its success. They point out that: "It has been fairly definitely established that hyperplastic lymphoid tissue is not highly radiosensitive and will not regress under irradiation unless the dosage is high." On the other hand, the two recurrences reported by Lederman were treated with radiation. One of these patients had remained free of disease for 15 months and the other for four years at the time of this report. A third case reported by Lederman had the tumor incompletely excised. Radium needles were inserted at the time of operation and the patient remained free of disease for three years, after which death occurred from other causes. Unfortunately the histopathology of Lederman's cases is incompletely reported. Certainly, the results of surgical excision have been so satisfactory that there is little place for radiation.

MALIGNANT ADENOLYMPHOMA

The question of the actual or potential malignancy of papillary cystadenoma lymphomatosum has been referred to by many authors, nearly all of whom regard them as benign. Martin and Ehrlich found no evidence of malignancy in any of their 22 cases. The case of Ssobolew has been discussed above. Lederman reported a case which died with definite metastasis following a combination of surgical and radiation treatment. The description of the micro-

scopic findings in this case is incomplete, but the epithelium was stated to be of the "basal" type.

Since these are the only cases of this type of tumor reported to be malignant, it is probable that true papillary (and nonpapillary) cystadenoma lymphomatosum is a benign tumor. That parotid tumors composed of adenoid and lymphoid tissues may occasionally be malignant, is illustrated by Case 4.

Case 4.—A white female age 48, was admitted to the Framingham Union Hospital, April 23, 1940, complaining of a slowly enlarging mass in the left parotid region of four months' duration. Physical examination revealed no abnormalities except a nodular, non-

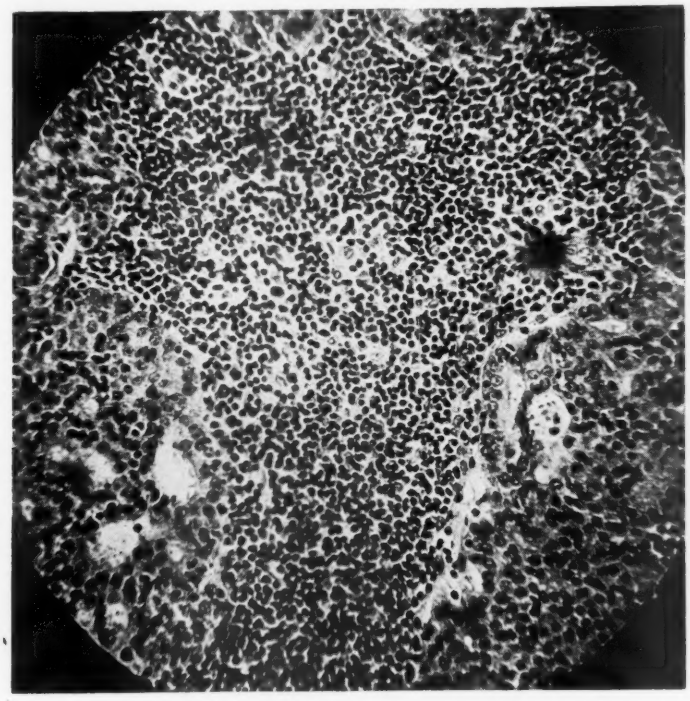


FIG. 7.—Case 4: Original tumor. Atypical glandular formations imbedded in a diffuse lymphoid stroma.

tender mass which lay in the substance of the parotid gland, posterior to the angle of the mandible. At operation, the tumor was found to be only partially encapsulated and to be deeply embedded in the substance of the parotid gland. With some difficulty it was excised, together with a considerable amount of surrounding, apparently normal, parotid tissue. The postoperative course was uneventful.

Examination of the specimen showed it to consist of a mass 4 x 2.5 x 2.2 cm. It was moderately firm in consistency, only partially encapsulated, with an uneven, nodular surface. On section, the peripheral portion was found to be normal parotid gland while the center consisted of tumor tissue which was firm, pale-gray, smooth and glistening.

Microscopic study showed no deviation from the normal in the sections from those portions which grossly resembled normal parotid gland. Beyond these areas there was widespread replacement of normal patterns by a new growth which consisted of atypical epithelial cells, irregularly mixed with lymphocytes (Fig. 7). The individual epithelial

cells were chiefly cuboidal, although displaying variations in size and shape. They had large round or oval nuclei with sharp limiting membranes and scanty chromatin networks. Some contained small nucleoli. The surrounding cytoplasm was homogeneous, compact and eosinophilic. In some areas these cells were disposed in acini from which new acini were being formed by budding. In other areas there were solid masses of cells.

Between the epithelial cells was a diffuse, dense infiltration of lymphocytic cells. These varied greatly both in size and cytologic characteristics. Some, rather large, with fine nuclear chromatin structure and two or more nucleoli, had the appearance of lymphoblasts. Others resembled mesolymphocytes, while others had the appearance of mature

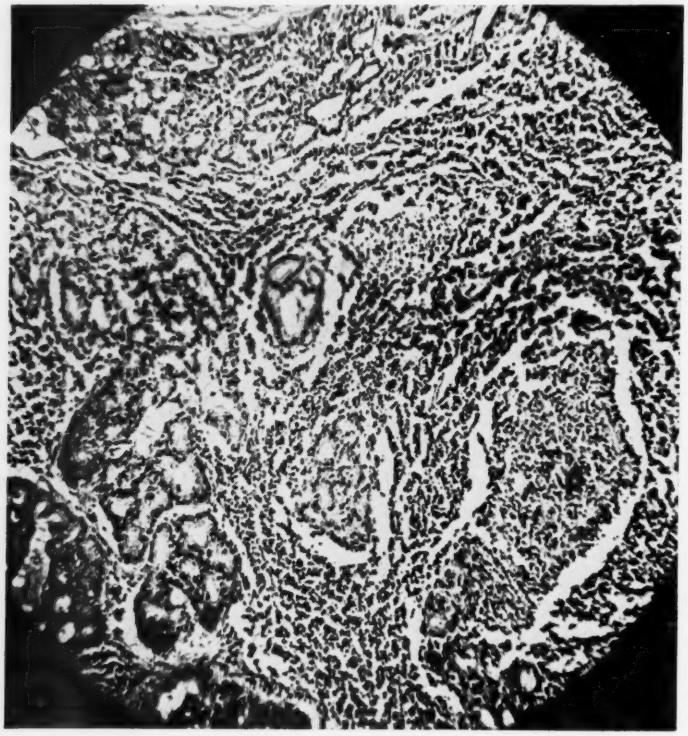


FIG. 8.—Case 4: First recurrence.

lymphocytes. All these different degrees of cellular differentiation indicated an active growth but lymph follicles were not seen.

Following operation the patient remained well for over three years, returning in August, 1943 with a recurrent tumor palpable in the retromandibular space underlying the old operative scar. At operation, the entire pharyngeal prolongation of the gland was found to be invaded by the tumor, which lay firmly wedged between the ramus of the mandible and the mastoid process. The facial nerve was isolated. Because it was inextricably involved in tumor tissue it was sacrificed and a wide resection of tumor and parotid gland was done. Convalescence was again uneventful.

Examination showed the specimen to measure 6 x 4 x 2.5 cm. Microscopic study (Fig. 8) showed the original characteristics to have been preserved. The lymphoid stroma showed all stages of cell maturation, from lymphoblasts to mature lymphocytes. The character of the epithelial proliferation did not differ greatly from that of the original tumor, except that the cells had assumed a more disorderly and infiltrative type of

growth. Individual cells showed great variation in size, shape and staining properties, and there were many atypical mitotic figures.

Following the second operation the patient remained well for one year, when she returned with a painless mass, 1.2 cm. in diameter, in the left submaxillary region. There was no evidence of recurrence in the region of the parotid or in the retromandibular region. No other enlarged nodes could be found in the neck or elsewhere. A suprahyoid neck dissection was done September 11, 1944.

Microscopic examination showed the histologic pattern to be similar to that of the preceding specimens (Fig. 9). The epithelial cells were anaplastic, with scanty, pale

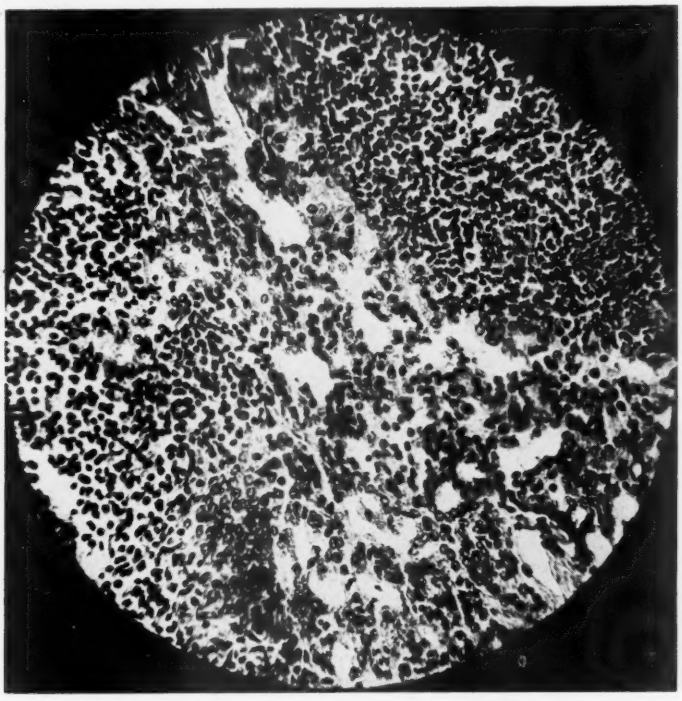


FIG. 9.—Case 4: Second recurrence, showing persistence of the mixed character of the growth.

cytoplasm, vesicular nuclei and many mitotic figures. Where the epithelial proliferation was most active and disorderly, the lymphoid stroma appeared greatly reduced, being entirely absent in places and limited to a few, irregularly scattered cells in others. Two small lymph nodes found in the removed tissue showed involvement with the same type of epithelial cells.

Following a review of the sections, a complete, radical dissection of the left side of the neck was advised. The patient refused to undergo further surgery. A course of roentgenotherapy consisting of 4200 r. was, therefore, given. A recent examination revealed no evidence of residual disease.

COMMENT: Case 4 presents unquestionable clinical and morphologic evidence of malignancy. Since its fundamental structure consists of an intimate mixture of glandular and lymphoid tissue, its relation to the benign tumors presents an interesting field for speculation. For instance, is this an example

of malignant degeneration of a benign adenolymphoma? While it is recognized that embryonal types of epithelium may dedifferentiate into malignant cells which have little resemblance to the parent cells, there is little in the morphology of the epithelium of this tumor to suggest such an hypothesis. The cell type and staining reactions are quite different. Furthermore, the relationship of epithelium to lymphoid stroma is entirely different. In Cases 1, 2 and 3 there is an harmonious relationship between the two elements, with no evidence of crowding or compression of one by the other. In Case 4 the lymphoid element represents an active part of the growth, but its relationship to the glandular element is not harmonious. The pattern is that of two unrelated tissues growing simultaneously but without any orderly, predisposed arrangement. It is our opinion, therefore, that this tumor is not the result of malignant degeneration of one of the benign tumors.

FIG. 10.—Parotid gland of human embryo 23 mm. long. Note similarity of glandular structures to those of the growth in Case 4, and the profusion of lymphocytes in the surrounding stroma. (Slide loaned through the kindness of the Department of Anatomy of Harvard Medical School.)

Malignancy arising in the so-called "mixed tumors" of the parotid gland is not uncommon.[27] Foci of lymphocytes, or areas of diffuse lymphoid stroma, are occasionally found in these tumors.[17] While the origin of the mixed tumors remains a debatable point, it is possible that malignant tumors consisting of a

combination of epithelial and lymphoid elements, could arise from portions of a mixed tumor. Because a careful study of many sections from the original tumor in this case has failed to reveal any of the microscopic characteristics usually associated with the mixed tumors, such an origin seems unlikely.

Proliferation of cells of the lymphoid series at the site of tumor growth has been frequently mentioned and variously interpreted. A defensive rôle has been suggested but has not been generally accepted. In the embryologic development of the parotid gland there is a close association of lymphoid cells with glandular tissue (Fig. 10). Because the morphology of the epithelial cells of this tumor is similar to that of cells in the developing parotid gland, and because the original tumor was found deeply embedded in the substance of the gland, it is probable that it arose as a result of the dedifferentiation of the parotid epithelium. Because of the close embryologic association of epithelium with lymphoid tissue, the latter, also as a result of neoplastic stimulation, has taken on a concomitant but independent growth.

CLASSIFICATION OF ADENOLYMPHOMATOUS TUMORS

It is obvious that there are a number of different tumors occurring chiefly in the parotid region, but occasionally in the submaxillary region, all of which have in common a close association of epithelial and lymphoid tissues. Of these the benign papillary cystadenoma lymphomatosum is the most common, and this is a rare tumor. Harris has emphasized the occurrence of a purely cystic variation of this tumor similar to Case 3. In addition, Plaut, Fine, and others, have described benign tumors in which the adenomatous epithelium is low cuboidal, scanty and embedded in a lymphoid stroma containing germinal centers. Finally, malignant tumors, such as Case 4 and the first case reported by Lederman, occur in the same region.

Because of the plethora of terms used to designate the benign tumors, and the relative infrequency of malignant tumors, and, furthermore, because of a lack of definite information concerning their histogenesis, the following classification, based on morphology, is suggested as a basis for further study. Under this classification "adenolymphoma" may be used as a general term to designate any tumor of this region whose morphology consists of a more or less exclusive combination of epithelial and lymphoid elements, whether benign or malignant:

Adenolymphoma:

A. Benign:
   1. Papillary cystadenoma lymphomatosum (Cases 1 and 2)
   2. Cystadenoma lymphomatosum (Case 3)
   3. Adenoma lymphomatosum (Plaut. Fine)

B. Malignant:
   1. Adenocarcinoma lymphomatosum (Case 4)
   2. Squamous carcinoma lymphomatosum (Lederman)

SUMMARY

1. Two cases of papillary cystadenoma lymphomatosum of the parotid salivary gland and one case of a purely cystic variety of the same tumor are

presented. These are rare tumors, occurring 4.5 times more frequently in men than in women.

2. The recorded theories of the histogenesis of these tumors are reviewed. We agree with Warthin that they probably arise from epithelium of the embryonic pharyngeal entoderm or upper respiratory tract, displaced to the region of the parotid gland.

3. Papillary cystadenoma lymphomatosum and its histologic variants are probably always benign. The results of surgical excision are excellent.

4. A morphologically and clinically malignant tumor of the parotid gland consisting of a combination of glandular and lymphoid tissue is presented. Its histogenesis is discussed.

5. A classification of adenolymphomatous tumors of the parotid and submaxillary regions is suggested.

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PILONIDAL CYSTS AND SINUSES: A TECHNIC FOR EXCISION AND PRIMARY CLOSURE

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THE PURPOSE of this paper is to point out a method of surgical treatment which has resulted in an unusually high percentage of primary healing and an unusually low recurrence rate in the face of the rigors of military training and combat. From a military point of view pilonidal cysts should be excised only when there have been repeated recurrences of acute infection, or where chronic drainage is so profuse that the soldier cannot adequately care for himself under military conditions. Whether or not to excise an infected pilonidal cyst in civilian life depends upon the attitude of the patient and will not be discussed here.

While undertaking various types of surgical procedures for pilonidal disease it was demonstrated by bacterial cultures that a pilonidal wound is a sterile wound at the time of block excision. Contamination in closed wounds apparently occurred during the early postoperative period by way of the moist skin sutures. Sulfanilamide in the wound did not protect the tissue from infection, and made the wound wet and difficult to close. Sulfanilamide crystals placed externally proved to be hygroscopic enough to control the natural moisture of the area and bacteriostatic enough to control the invasion of the wound by infecting bacteria. It was also observed that wound reaction to cotton suture material was much less than to catgut, so a standard cotton technic was decided upon for this operation.

SURGICAL REGIMEN

As a result of these observations, the following standard regimen was developed:

Pilonidal cysts showing acute inflammation are allowed to "cool-off" before operation. If drainage is inadequate, or if an abscess has formed, incision and drainage is performed, and the wound is packed open with vaselined gauze. Dakin's solution, hot sitz baths, and compresses are used to allay the acute infection. When cultures reveal staphylococci, penicillin is used. Subsequent curative surgery, if indicated, is undertaken only after the acute inflammation has subsided. This requires from two to three weeks. Early operation frequently results in a wet wound in which adequate hemostasis is difficult or impossible to obtain.

When the acute infection has adequately subsided, or if the infection is chronic, block excision of the cyst and sinuses followed by primary closure is done. The buttocks are strapped to the sides of the table to afford good expos-

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ure, and the area is thoroughly cleansed with soap and water followed by mercury bichloride solution. The area is carefully draped with moist towels and the bottom one is clipped into the skin just above the anus to protect the field from contamination (Fig. 1). The cyst is usually injected with methylene blue in peroxide solution if a patent sinus is present, and an elliptical incision is made. In cases where sinus openings are quite far lateral and where a "Y"-type of incision would seem advisable, the elliptical incision should still be used and carried laterally far enough to include the sinus openings. Actually, when very wide skin excisions are necessary, they can be closed without marked tension if the underlying subcutaneous tissue is properly built-up. We have several cases where large cysts with sinus ramifications necessitated elliptical incisions ten centimeters wide, and these were closed without difficulty.

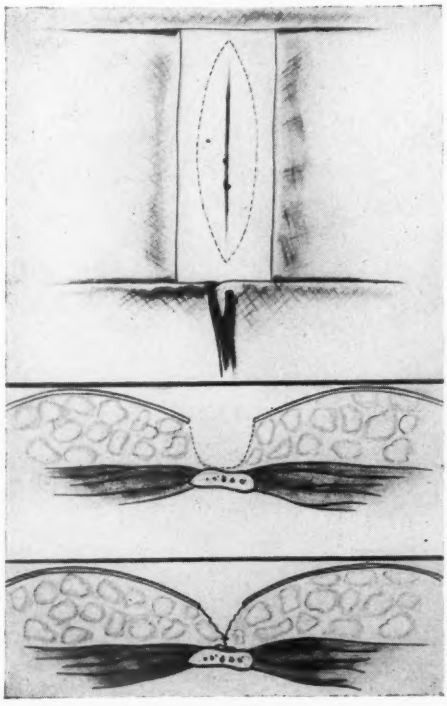

FIG. 1

FIG. 2

FIG. 3

FIG. 1.—The area is carefully draped with wet towels. The bottom towel is clipped to the skin to protect the field from contamination.

FIG. 2.—The block excision must assure a thorough removal of the cyst. Undermining should be avoided.

FIG. 3.—Care is taken to place the bottom row of sutures at a level where the deep tissue can be approximated without undue tension. The sacral fascia is never included in the deep suture layer.

The block excision must be wide enough to assure a thorough removal of the cyst, the sinuses, and all the tissue involved by chronic or subacute inflammation. The walls of the resulting wound should be vertical or sloping from the skin toward the midline when the adhesive traction straps are in place (Fig. 2). Undermining should be scrupulously avoided, or resorted to only in exceptional instances. Cutting into adjacent muscles and the creation of muscle flaps is not advisable and is never necessary.

All bleeding points are tied with No. 80 cotton. A minimal amount of tissue is included in each tie and the ties are cut "on the knots." The wound is irrigated with normal saline to remove any possible contamination, measured, and the adhesive traction straps are removed. The buttocks are pressed together so as to bring the walls of the excised area into apposition with each

other in order to determine the optimum levels at which to place the rows of subcutaneous sutures.

The wound is closed with No. 40 cotton sutures. The optimum level for the deepest layer of sutures is at that level where the fat can be approximated without undue tension. This level is usually a varying distance up the side of the wound rather than at the bottom of the wound, depending upon the width of the defect. The sacral fascia should not be included in the deepest row of sutures. These points in technic are emphasized. Sutures placed under much tension will pull through the fat during the early postoperative period, causing fat necrosis. The bottom row of sutures usually folds fatty tissue into the

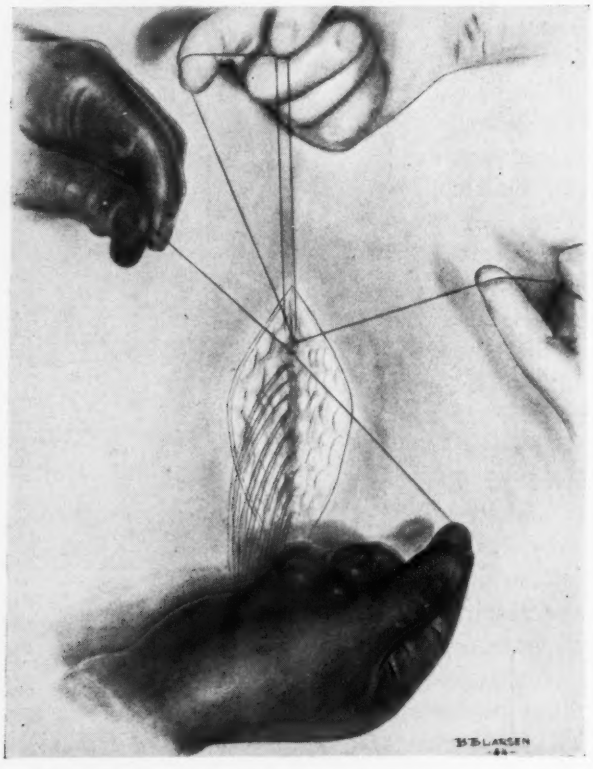

FIG. 4.—By properly holding the untied sutures, very little tension is applied to each suture in turn as it is tied. (Light gloves the assistant, dark gloves the operator)

bottom of the wound and no dead space remains. In some instances a dead space cannot be avoided; but this is of much less importance than obtaining good closure of the overlying fat without undue tension (Fig. 3).

The more superficial subcutaneous fat is built up with as many rows of sutures as are needed. Usually two rows are sufficient, but an additional half row is sometimes necessary at the lower end. (In one case, four and one-half rows of sutures were necessary to properly build up the subcutaneous fat.) The sutures are placed a row at a time, according to well-established silk tech-

nic, and then tied. Split-eye French needles facilitate this technic. By properly holding the untied sutures, very little tension is applied to each in turn as it is tied (Fig. 4). A strong suture line without bulky suture material is obtained. The tissue should be built up so that the skin edges are level and in close approximation. Care must be taken that the topmost row of sutures is not placed too close to the skin. There should be a space of from three to six millimeters between the knots of this suture layer and the deep portion or base of the skin (Fig. 5).

The skin is closed with meticulous accuracy by fine interrupted cotton sutures placed about five millimeters apart. These sutures are placed so as not to penetrate into the subcutaneous tissue as an additional safeguard against invasion of the fat by bacteria (Fig. 6). Sulfanilamide crystals are dusted on the closed incision, and a pressure dressing of mechanic's waste is strapped in place securely with adhesive tape.

Postoperatively, the dressing is not disturbed unless it becomes moist, bloody or contaminated, in which case it is changed immediately. When it is changed the sulfanilamide crystals are brushed off, or, if adherent, they are removed with boric acid or mercury bichloride solution. The dressing is then reapplied along with sulfanilamide crystals or zinc stearate powder. (Fifty controls showed no appreciable difference between the wound-healing in cases where sulfanilamide crystals were used throughout the postoperative course and in cases where zinc stearate powder was used after 72 hours following operation. This was not true if zinc stearate was used immediately following surgery. Sulfanilamide crystals tend to spill into the bed and cause discomfort. No discomfort is caused by zinc stearate.) After the initial pressure dressing has been removed the subsequent dressings are held firmly in place with gauze ties placed in adhesive straps. The incision is frequently inspected and zinc stearate powder or sulfanilamide crystals are reapplied as often as needed. If abnormal reaction occurs about a skin suture, that suture is immediately removed. Routinely, skin sutures are removed on the seventh to tenth postoperative day.

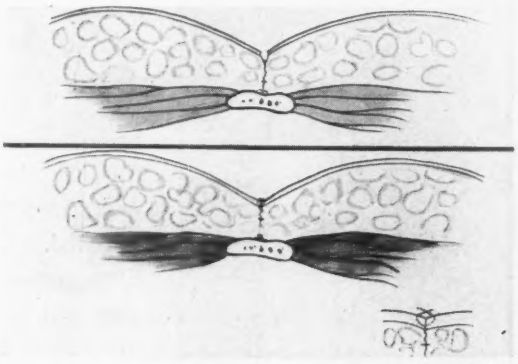

FIG. 5

FIG. 6

FIG. 5.—The tissue should be built up so that the skin edges are level and in close approximation. There should be a space of from 3 to 6 mm. between the knots of the top suture layer and the base of the skin.

FIG. 6.—The skin is closed with meticulous accuracy. The sutures are placed so as not to penetrate into the subcutaneous tissue.

After the operation, these patients are given a liquid diet for three to four days, following which mineral oil is given to keep their stools soft. They are up and about in 14 days. In civilian practice, patients would be ready for discharge from the hospital at this time. In the Army the patient remains in the hospital, and after the third week is given reconditioning training to fit him for active duty six weeks following operation.

SUMMARY OF CASES

This report covers 225 consecutive cases of pilonidal disease operated upon and cared for by this surgical regimen. Two hundred and nineteen of the wounds were measured for length, width, and depth; one wound was measured for length and width; five wounds were not measured. Measurements were made with the adhesive traction in place. The average size of the open wounds was 7.7 cm. long, 4.1 cm. wide and 3.7 cm. deep. The largest defect measured 16 cm. long, 10 cm. wide, and 5.5 cm. deep. This wound healed without complication (Fig. 7). In ten cases, other curative operations had been previously attempted. Three cases each had had three previous radical excisions, one case had two, and five cases had one attempted curative procedure. Low spinal anesthesia was used in all cases unless contraindicated. The operations were performed, after the procedure had been standardized, by the various Officers of the General Surgical Service and the Residents in Surgery at this Hospital. The average operating time for all cases was 36 minutes.

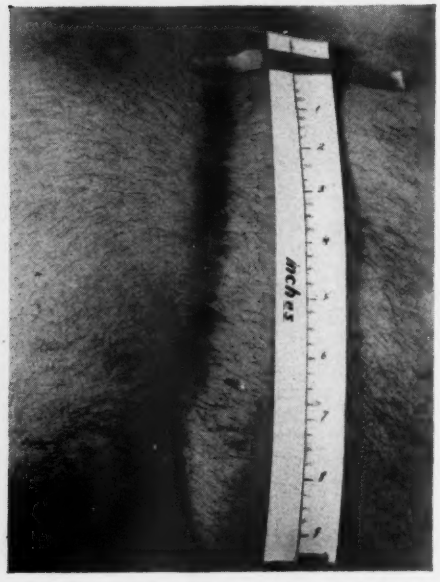

FIG. 7.—Photograph taken 18 days after pilonidal cystectomy. Block excision measured 16 cm. long, 10 cm. wide, and 5.5 cm. deep. Primary healing, without complication.

IMMEDIATE RESULTS

Primary healing occurred in 218, or 96.9 per cent, of these 225 cases, while infection with secondary healing occurred in seven cases, or 3.1 per cent, (Chart I).

The 218 cases which had primary healing have been divided into five subgroups:

(a) Those cases which healed by absolute primary intention, showing no clinical abnormality of any kind in the wound during the healing period. There were 191 of these, or 84.9 per cent of the total 225 cases.

(b) Those cases in which the skin edges were not approximated with

complete accuracy, resulting in one skin edge overlapping the other, causing a small area of separation of the epithelium. There were 11 of these cases, or 4.9 per cent of the total.

(c) Pressure necrosis of the skin due to the technical error of tying the skin sutures too tightly. This occurred in two cases, or 0.9 per cent of the total. The necrosis did not exceed five skin sutures in either case.

(d) Cutaneous "stitch abscess" occurred in seven cases, or 3.1 per cent of the total. A cutaneous "stitch abscess" is defined as a purulent reaction about a skin suture which quickly subsides on the removal of the involved suture.

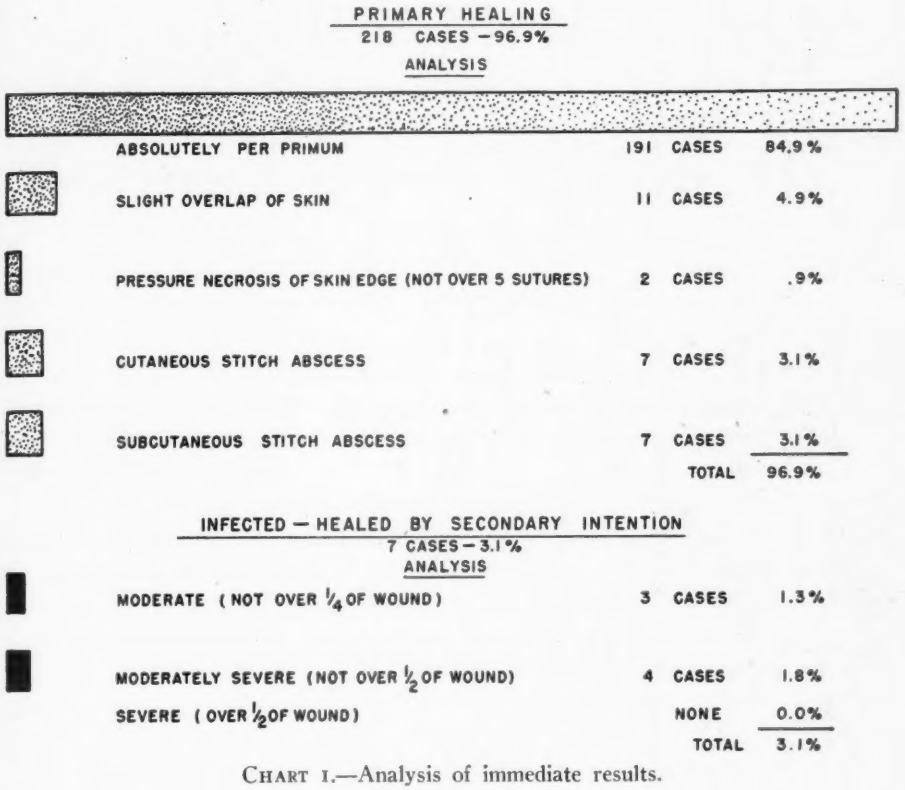
PRIMARY HEALING
218 CASES — 96.9%
ANALYSIS
ABSOLUTELY PER PRIMUM 191 CASES 84.9%
SLIGHT OVERLAP OF SKIN 11 CASES 4.9%
PRESSURE NECROSIS OF SKIN EDGE (NOT OVER 5 SUTURES) 2 CASES .9%
CUTANEOUS STITCH ABSCESS 7 CASES 3.1%
SUBCUTANEOUS STITCH ABSCESS 7 CASES 3.1%
TOTAL 96.9%
INFECTED — HEALED BY SECONDARY INTENTION
7 CASES — 3.1%
ANALYSIS
MODERATE (NOT OVER 1/4 OF WOUND) 3 CASES 1.3%
MODERATELY SEVERE (NOT OVER 1/2 OF WOUND) 4 CASES 1.8%
SEVERE (OVER 1/2 OF WOUND) NONE 0.0%
TOTAL 3.1%

CHART 1.—Analysis of immediate results.

(e) Subcutaneous "stitch abscess" consisting of infection about one or two, but not exceeding two, subcutaneous cotton sutures. There were seven of these cases, or 3.1 per cent of the total. A subcutaneous "stitch abscess" is defined as the purulent reaction about a subcutaneous suture which quickly subsides on the removal of the involved suture.

The seven cases which had secondary healing due to infection have been divided into three subgroups:

(a) Moderate infection, which involved not over one-fourth of the pilonidal wound. There were three cases of moderate infection, or 1.3 per cent of the total.

TABLE I

SUMMARY OF CASES OF SECONDARY HEALING FOLLOWING INFECTION* IN THE IMMEDIATE POSTOPERATIVE PERIOD

No.	Infection	Height	Weight	Recent Inflammation (Acute)	Size of Excision Length, Width, Depth (Cm.)	Special Operative Notes	Time of Operation (Minutes)	Remarks
1.	Moderate	6′1¾″	218	I & D 200 cc. pus 18 days before operation	12 x 6.5 x 4	Approximately 4 times normal amount of bleeding. Required great deal of suture material	87	Third postoperative day quite marked induration lower end of incision. Seventh day wound open lower end with moderate purulent drainage. No recurrence 185 days postoperative
2.	Moderate	5′10¾″	185	None	10 x 5 x 3.5		45	Fifth postoperative day evidence of superficial infection, one-half of skin sutures removed. Completely healed by 23rd postoperative day. No recurrence 158 days postoperative
3.	Moderate	5′11″	230	I & D abscess 2nd hospital day; I & D 30th hospital day; operation 33 days after last I & D	Not recorded	Very wet wound. Operator questioned if attempt at closure justified	67	Second postoperative day 10 cc. hematoma evacuated and area became secondarily infected. Completely healed 28th postoperative day. Recurrent drainage on 38th postoperative day. Wound reopened and granulation tissue excised on 56th postoperative day. Slight recurrent drainage three months later which healed rapidly. No evidence of recurrence 219 days postoperative
4.	Moderately severe	5′10½″	157	Moderately inflamed. Compressed for 4 days preoperative	6 x 2.5 x 2.5	Very wet wound. Oozing could not be adequately controlled. Hot packs, *etc.*, at least 3 times usual number of ties	57	First postoperative day dressing saturated with blood. Evacuation of infected hematoma from superficial portion of wound 6th postoperative day. This portion healed by secondary intention. No evidence of recurrence 110 days postoperative
5.	Moderately severe	5′10″	200	Increased drainage and soreness for three weeks before operation	5 x 3 x 3		18	Initial healing normal except for moderate induration upper end of wound. 18th postoperative day fluctuant area at the upper end, 5 cc. of pus. Healed rapidly. Recurrent fluctuant abscess 60th postoperative day, incised and drained, several subcutaneous cotton sutures removed. Apparently healed 12 days later. Drainage recurred one month later. Healed slowly by secondary intention. No recurrence 220 days postoperative
6.	Moderately severe	6′2″	180	None	10 x 2		40	There was marked overlapping of skin resulting in superficial infection lower one-half of wound which healed by secondary intention. Recurrent drainage 61 days postoperative and two subcutaneous infected cotton sutures were removed. No recurrence 236 days postoperative
7.	Moderately severe	5′11″	225	Chronic profuse drainage	8 x 4 x 3.5	Unusually wet wound	50	Bleeding on defecation at stool 6th postoperative day which recurred 2 days later and infection in the wound became evident. Wound opened 3 cm. in length and 1.5 cm. in depth, packed. Healed by secondary intention. No recurrence 219 days postoperative

* Moderate infection—not over one-fourth of wound involved.
Moderately severe infection—not over one-half of wound involved.
Severe infection—more than one-half of wound involved. (No cases.)

(b) Moderately severe infection, in which not over one-half of the wound was involved. There were four cases of moderately severe infection, or 1.8 per cent of the total.

(c) Severe infection, in which over one-half of the wound became infected. There were no cases of severe infection.

The seven cases which became infected in the immediate postoperative period are summarized in Table I. Analysis reveals that five of the seven had either recent acute inflammation or profuse chronic drainage. In four of the five, the operative wounds were so wet that special remarks to that effect were incorporated in the operative notes. In three of these postoperative bleeding in the wound was evidence of inadequate hemostasis. Cases 1, 3, 4, 5 and 7 emphasize the necessity for patience in allowing inflammation to subside. If possible, all clinical evidence of inflammation should be cleared up before curative surgery is attempted. In Case 6, infection occurred because there was overlapping of the skin, which was a technical error. There is no obvious explanation for the infection in Case 2.

LATE RESULTS

Of these 225 cases of pilonidal cystectomy, 220 were followed after leaving the hospital for an average of 124 days after operation. It was necessary to gather some of the information by letter from soldiers serving in various Theaters of War. After returning to military duty, five patients (2.2 per cent) could not be followed; 197 (87.6 per cent) had no recurrent drainage or other evidence of infection at the site of operation; 23 (10.2 per cent) had recurrent drainage.

The 23 cases which had recurrent drainage are summarized in Table II. Analysis reveals that no case of drainage represented a true recurrence of the pilonidal cyst. In no case was reëxcision indicated. In most instances, drainage was due to infection about one or two subcutaneous cotton sutures, and the lesion healed when the offending suture material was removed. It is significant that these sutures are usually at the lower end of the wound where it is difficult to keep the sulfanilamide crystals on the incision, and where the danger of contamination is greatest. It is also significant that there is no instance of drainage from the deep portion of a wound where a "dead space" is most likely to occur at the time of operation.

SUMMARY

A successful surgical technic for primary closure following complete excision of pilonidal cysts is presented. From a military point of view, radical surgery should be reserved for patients with frequently recurring acute infections or profuse chronic drainage. Curative operation is delayed until the lesion is quiescent. The lesion is completely removed by elliptical block excision. Undercutting, muscle flaps, and extensive dissections with plastic closures are not necessary or desirable. The wound is closed with cotton sutures employing meticulous "silk technic." Care is taken to place the deepest row of

* Moderate infection—not over one-fourth of wound involved.
Moderately severe infection—not over one-half of wound involved.
Severe infection—more than one-half of wound involved. (No cases.)

TABLE II

SUMMARY OF CASES WHICH HAD HEALED BUT DEVELOPED DRAINAGE DURING FOLLOW-UP PERIOD

No.	Postoperative Difficulty	Height	Weight	Recent Inflammation (Acute)	Size of Excision Length, Width, Depth (Cm.)	Special Operative Notes	Time of Operation (Minutes)	Remarks
1.	None	5′7″	168	Recent acute inflammation draining pus	Not recorded	Lower end of incision is 1 cm. from anal orifice	28	Drainage from extreme lower end of excision on 39th postoperative day. Single cotton subcutaneous stitch. No recurrence 187 days postoperative
2.	None			Indurated, up and to left at point of recent drainage	7 x 4		26	Drainage on 40th postoperative day. One subcutaneous cotton stitch. No recurrence 106 days postoperative
3.	None	6′1″	205	Palpable indurated mass 11 o'clock from sinus	12 x 6 x 3.3	Very extensive cyst. Opened into during operation	47	50th postoperative day slight bleeding. One subcutaneous cotton suture. Healed in 8 days. No recurrence 149 days postoperative
4.	None	5′7″	173	I & D 8 days before operation	3.5 x 1.5	Wet wound	50	46th postoperative day pain. 48th postoperative day drainage. Wound opened 1.5 by 1 by 0.3 cm. No suture found. Healed in 10 days. No recurrence 103 days postoperative
5.	None	5′6″	250		12 x 7 x 3	Extremely fat	33	115th postoperative day slight drainage. One subcutaneous cotton suture
6.	None	6′	155	None	3 x 1.75 x 1.5		55	49th postoperative day slight drainage. One stitch removed. Healed Drainage recurred 55 days later. Three subcutaneous cotton sutures removed. No recurrence 162 days postoperative
7.	None	5′9″	170	None	8.5 x 3.5 x 3		25	48th postoperative day drainage from extreme lower end of incision. Two subcutaneous sutures. No recurrence 138 days postoperative
8.	None	5′8″	175	Purulent drainage	10.5 x 6.8 x 5		39	46th postoperative day slipped on ice, fell on buttocks, split, open scar superficially 1 cm. long
9.	None	5′6″	155	One sinus opening	6 x 3.5 x 3		30	43rd postoperative day small subcutaneous abscess drained
10.	None	6′	185	None	8.8 x 4 x 2.5		17	45th postoperative day epithelium denuded from small portion of scar due to irritation of dense hair doing "sit-ups." One month later recurrence of same difficulty. One month later slight drainage. One subcutaneous cotton suture
11.	None	5′8½″	155	None	7 x 4 x 2		40	54th postoperative day drainage. Single cotton suture. No recurrence 90 days postoperative
12.	None	5′7″	170	None	8 x 4 x 4		40	(Letter) One month after operation after trip across country in a day coach, there was drainage followed by healing, and no recurrence 135 days postoperative
13.	None	5′5½″	168	None	5.7 x 4.2 x 3.1		38	(Letter) 108th postoperative day drainage. Wound opened 2 x 1 x 1 cm., curetted in another hospital. Healed rapidly
14.	None	5′10¾″	255	Mildly infected	13 x 8 x 6	Several widespread sinus openings. Wide, large incision. Very fat	45	135th postoperative day bloody drainage. Three pin point openings. Wound opened 2.5 cm. long, 6 mm. deep. Hair.* An immediate closure with wire. Primary healing. No recurrence 187 days postoperative (49 days after second operation)
15.	None	5′5″	150	None	6 x 2.5 x 3		23	87th postoperative day superficial epithelium over scar, 0.5 cm. long, 0.3 cm. wide, denuded by irritation of dense, coarse hair. No purulent drainage. No recurrence 112 days postoperative

15.	None	5′5″	150	None	6 x 2.5 x 3		23	187 days postoperative (49 days after second operation) 87th postoperative day superficial epithelium over scar, 0.5 cm. long, 0.3 cm. wide, denuded by irritation of dense, coarse hair. No purulent drainage. No recurrence 112 days postoperative

TABLE II—Continued

SUMMARY OF CASES WHICH HAD HEALED BUT DEVELOPED DRAINAGE DURING FOLLOW-UP PERIOD

No.	Postoperative Difficulty	Height	Weight	Recent Inflammation (Acute)	Size of Excision Length, Width, Depth (Cm.)	Special Operative Notes	Time of Operation (Minutes)	Remarks
16.	None	5′8″	147	Small amount of purulent drainage	7.5 x 5 x 4	Incision extends down into rectal sphincter	75	41st day postoperative noticed pain. Eight days later draining. Small opening extreme lower end. Subcutaneous cotton suture. No recurrence 192 days postoperative, but letter written on 286th postoperative day says he had recurrent drainage. Surgeon reports discharge due to traumatic abrasion of scar. No evidence of recurrence of cyst
17.	None	5′10″	150	Tender	No record	One opening 3 cm. left of midline	40	45th postoperative day drainage extreme lower end of wound. One subcutaneous cotton suture. No recurrence 285 days postoperative
18.	Skin separation	5′8″	165	None	9 x 5.5 x 3		35	Recurrent drainage 45th postoperative day. Subcutaneous cavity 2.5 cm. long opened; secondary healing. No recurrence 126 days postoperative
19.	Skin separation	5′7½″	170	None	11.5 x 7 x 4		40	107th postoperative day drainage lower end, opened 2.5 cm. 1 cm. Healing progress slow. 198 postoperative day secondaryx closure 1.5 cm. with wire. Primary healing. No recurrence 128. days postoperative
20.	Subcutaneous "stitch abscess"	5′8″	185	Chronic continuous drainage	5 x 3 x 2.5		30	One subcutaneous cotton suture. Recurrent drainage from same area 83 days postoperative. No evidence of further recurrence 150 days postoperative
21.	Moderate infection	5′11″	230	I & D abscess 2nd hospital day; I & D 30th hospital day; operation 33 days after last I & D	Not recorded	Very wet wound. Operator questioned if attempt at closure justified	67	Second postoperative day 10 cc. hematoma evacuated and area became secondarily infected. Completely healed 28th postoperative day. Recurrent drainage on 38th postoperative day and wound reopened and granulation tissue excised on 56th postoperative day. Slight recurrent drainage three months later which healed rapidly. No evidence of recurrence 219 days postoperative
22.	Moderately severe infection	5′10″	200	Increased drainage and soreness for three weeks before operation	5 x 3 x 3		18	Initial healing normal except for moderate induration upper end of wound. 18th postoperative day fluctuant area at the upper end should be determined. 5 cc. of pus. Wound healed rapidly. Recurrent fluctuant abscess 60th postoperative day incised and drained, several subcutaneous cotton sutures removed. Apparently healed 12 days later, but drainage recurred one month later. Healed slowly by secondary intention. No recurrence 220 days postoperative
23.	Moderately severe infection	6′2″	180	None	10 x 2		40	There was marked overlapping of skin resulting in superficial infection lower one-half of wound which healed by secondary intention. Recurrent drainage 61 days postoperative and two subcutaneous infected cotton sutures were removed. No recurrence 236 days postoperative

* This lesion was located in the midportion of the old scar and was very superficial. Therefore, it would seem this is not a true recurrence of the pilonidal cyst but a collection of hair, growing from hair follicles partly amputated at the original operation, which did not find its way through to the surface.

sutures at a level where the deep tissue can be approximated without undue tension. The sacral fascia is never included in the deep suture layer. Sulfanilamide crystals are dusted on the closed incision, where they control moisture and bacterial growth sufficiently to protect the wound from infection, and a pressure dressing is applied.

This report covers 225 consecutive cases of pilonidal disease operated upon and cared for by this surgical regimen. Primary healing occurred in 218 cases (96.9 per cent), and secondary healing occurred in seven (3.1 per cent). During the follow-up period, which averaged 124 days, 197 cases (87.6 per cent) had no recurrent drainage, 23 (10.2 per cent) had recurrent drainage, and five (2.2 per cent) could not be followed. No case with recurrent drainage represented a true recurrence of the cyst, and in no case was reëxcision indicated.

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BASIC PRINCIPLES IN GERIATRIC SURGERY*

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"Cast me not off in the time of old age;
When my strength faileth, forsake me not."

Psalm 71:9

IN JULY, 1939, a new and well equipped 1,500 bed municipal hospital was opened in New York City for the treatment of chronic disease. It was the product of the foresight and the meticulous planning of the Commissioner of Hospitals, the late Dr. S. S. Goldwater. He had realized for many years that there were insufficient accommodations for patients with chronic diseases, that for the most part therapy in such disease was inadequate because of forced curtailment of hospital days, and that there existed a crying need for research in the causes, prophylaxis and treatment of chronic illnesses. The hospital was so organized that at least a beginning in the solution of some of these problems might be made. A sufficient number of surgical beds was provided, with no time limit on hospitalization. This afforded an unusual opportunity for continuous and unhurried study, therapy and the observation of end-results.

The primary purposes of the hospital were such that logically most of the surgical beds have been occupied by patients in the old-age group. In many instances they had been shuttled from hospital to hospital or they had remained at home without proper attention or therapy. They had become custodial cases, the victims of therapeutic defeatism and inadequate facilities for their care. It was realized that there would be many difficult problems, but the challenge was met by the conscientious application and coöperation of the hospital personnel and by the guidance and executive ability of the Surgical Director of our Division, Dr. Condict W. Cutler, Jr.

It is the aim of this paper to present briefly some of the more basic principles in geriatric† surgery. Many of these are well known, but they bear repetition. A detailed description of pathologic conditions and technics will not be attempted.

OLD AGE DEFINED

Gerontology relates to the study of the aging process. It is difficult to establish a line at which old age begins. The expressions "a man is as old as he feels" and "a man is as old as his arteries" are well known. Generally speaking, when the degenerative processes, whether due to inflammation,

* Read before the New York Surgical Society, October 24, 1945.

† The word "geriatrics," coined by Nascher,[1] is derived from the Greek: γηρας, old age, and ιατρικός, relating to a physician.

metabolic or neoplastic changes, affect individuals past the age of 60, it is customary to place such people in the old age-group. And yet many people past 70, who feel and function perfectly well, are nevertheless called "old." They are chronologically rather than biologically old. The process of aging is slow, progressive and persistent and it may or may not be "graceful." All tissues and organs in an individual do not necessarily age synchronously. In senescence homeostasis is diminished. Senility implies physical defects and degenerative conditions accompanied by social maladjustment and by impairment of intellect, emotions and sustained effort.

IMPORTANCE OF GERIATRIC SURGERY

Geriatric surgery is surgical therapy for the aged. Invalidism is increased with advancing age. Dublin's[2] statistics show the following figures:

TABLE I

Ages	Invalids per 1,000
All ages	11
65–74	53.5
75–84	72.7
Above 85	106.2

The problem of the care of the aged is becoming more and more important as life-span increases. Based on the latest census figures, there was a 7.2 per cent increase in population between 1930–1940. In the same period there was an increase of 35 per cent of persons over 65 years of age. In 1940, life expectancy was 63 years, and in 1960 it should reach 68 years. It is estimated actuarially that in 1980, 40 per cent of the population will be over 45 years. Hence the health, social, economic and political significance of increase in life-span must be stressed.

In various parts of the country funds have been provided for research in gerontology, with special reference to its pathology and biochemistry. The ultimate goal is the promotion of longevity, with usefulness, reasonably good health and youthful stamina. It is important to "add life to years and years to life."

GENERAL CONSIDERATIONS

In the broad sense, the problems which are presented by surgery for the aged are produced by accompanying medical conditions and their complications. The most important are those found in the cardiovascular and renal systems. Large numbers of patients are also debilitated and dehydrated. These conditions are caused chiefly by nutritional failure due to inadequate diet, faulty assimilation and elimination, avitaminosis and poor water balance. All of these may be increased by the patient's inertia and by poor supervision of his regimen. Attention to general hygiene, diet and supportive therapy, in order to improve function and to produce better chemical, water and vitamin balance, create a greater sense of well-being which is a necessary preparation for operation. Early postoperative out-of-bed and ambulatory supervision have been pursued in selected cases. As a result, pneumonia,

circulatory failure and pulmonary embolism have been minimized, morale has been strengthened and convalescence shortened. Early motion, frequent change of position and deep breathing have been encouraged.

INTERDEPENDENCE OF SURGERY AND MEDICINE

In geriatric surgery especially, it is important for the surgeon to have a good concept of general medicine and the basic sciences. With the advent of specialization and the limitations placed on physicians by specialized organizations and Boards, there has been an unfortunate tendency for technical specialists to run away from medical problems and to abandon the use of the stethoscope and the pleximeter finger. It is necessary for the surgeon to feel the responsibility of the relationship of medical problems to surgical conditions and then to seek medical and specialized consultation and corroboration. These medical problems very often determine the plan of surgical procedure, the preoperative and postoperative treatment and the most suitable methods for rehabilitation.

INDICATIONS FOR OPERATION

Operative intervention in the aged should be considered when surgical disease is an immediate or future threat to life and when such disease produces continued discomfort, pain, disability, economic loss and interference with comparatively normal routine. Operative therapy may give a welcome symptomatic improvement, permanent relief or cure. The decision as to operative indications, their type and magnitude must necessarily come from what is known as surgical judgment. This is developed from cumulative experience and honest and analytic appraisal of facts.

The most frequent surgical conditions in the aged on our surgical service are infections, malignancy in the gastro-intestinal and urinary tracts and in the reproductive system, in the breast and skin, obstruction in the gastro-intestinal and urinary tracts and in the biliary system, calculus disease, ovarian cyst, uterine fibroids, prolapsus uteri, hernia, hydrocele, appendicitis, bladder diverticulum, hemorrhoids, varicose veins, fractures (especially those involving the neck of the femur), gangrene of the lower extremities resulting from peripheral vascular disease, decubitus ulcers, contractures at the knees, fistulae and sinuses.

THE SURGICAL RISK

Old age does not necessarily preclude surgical procedures which might save or prolong life or produce continued physical comfort or relief of pain, and economic, functional and social usefulness. How easy it is and, strangely enough, how difficult it can be for old people to die! The tremendous strides which have been made and are continuing to be made in medicine and surgery necessitate the abandonment of outdated defeatist attitudes and the adoption of a more progressive and optimistic outlook in geriatric surgery. Such an outlook has encouraged hazardous procedures for the aged after considered

judgment, Staff consultation and proper evaluation of the facts on the hospital chart. The fear and implication of mortality statistics have not been deterrents to surgical therapy when there was hope for improvement or cure. The family and, in selected instances, the patient have been made to understand the surgical risk and the end-result which could be expected.

In evaluating the surgical risk, a number of factors must be considered. The most constant one is diminished reserve in the aged. The choice of operation and its magnitude must be balanced against the expected beneficial results, the current enjoyment of life and life expectancy without surgery. As a general rule, heredity and the previous methods of living help to determine the operative risk. Shock is insidious and easily produced and recovery from shock is highly speculative and slow. The increased dangers from anesthesia, infection and retarded repair are evident. Conservatism by delay at the wrong time may be very costly. This is especially true in spreading infection and in obstruction in various organs.

TABLE II

OPERATIVE MORTALITY STATISTICS

Source	Age-Groups	Number of Major Operations*			Mortality Per Cent		
		Males	Females	Total	Males	Females	Average%
Goldwater Memorial Hospital	61– 70	152	50	202	15.78	22.	18.89
	71– 80	148	47	195	24.18	27.6	25.89
	81– 90	38	12	50	44.73	25	34.86
	91–100		2	2			
	101–110		1	1			
	Total	338	112	450			22.66
Bailey[3]	60–84			185			7.6
Parsons[4] & Purks	60 and over			100			17
Clagett[5]	60 and over			1204			9
Hay[6]	70 and over			536			16.6
Evans[7] & Key	60 and over			83			7.2
Grand total				2558	Grand average, %		13.1

* The emergency operations were 12.88% of the total number.

TOLERANCE TO OPERATIVE THERAPY

With increasing experience in geriatric surgery, it has become evident that the aged stand operation far better than is generally believed. It is fair to state that in our patients the surgical risk has been very bad. The majority have been in other municipal hospitals for long periods of time or they have been guests of a municipal home. Others have been under treatment for chronic illnesses on the medical or neurologic wards of the Goldwater Memorial Hospital. In many instances the pathologic state on admission was so far advanced that patients were moribund, or nearly so.

Table II indicates our operative mortality statistics. They include only those patients who died within one month after operation. The table also gives comparative mortality statistics from other clinics. The higher rate

of mortality among the patients at the Goldwater Memorial Hospital is explained by the above mentioned conditions.

For comparison, Table III illustrates the mortality rate in all age-groups in various clinics after typical major procedures.

TABLE III

OPERATIVE MORTALITY STATISTICS OF STANDARD SURGICAL PROCEDURES IN ALL AGE-GROUPS IN VARIOUS CLINICS

Source	Type of Operation	Mortality Per Cent
Cattell[8]	Biliary tract surgery	1.1
Dick[9]	Nephrectomy	2.2
Colp,[10] *et al.*	Subtotal gastrectomy	4.26
Watson[11]	Hernioplasty (for non-strangulated hernia)	1
Leigh,[12] *et al.*	For intestinal obstruction	13.2

A comparison of the mortality statistics in Tables II and III indicates that the operative risk in the aged is not prohibitive. The contributing factors for these encouraging figures are the modern concepts of preoperative investigation and preparation, refined technics and stage operations when indicated, better anesthesia and better postoperative care. The production and maintenance of comparatively normal chemical, water and vitamin balance and the adequate improvement of organic medical conditions by appropriate therapy all help to diminish morbidity and mortality. Long periods of preparation for operation, accompanied by the use of vitamins and a high protein diet and amino-acids, are frequently necessary. The use of blood transfusions is an established routine, but overloading of the vascular system with fluid is to be avoided, especially in those with diminished cardiac reserve. In elective procedures, bedrest for several days before operation is advisable.

Technics should be as simple as possible. Speed is essential, but not at the expense of minimal operative manipulation and trauma. Leonard Wright[13] stated in "Display of Dutie," written in 1589: "In a good surgeon a hawk's eye, a lion's heart and a lady's hand." Careful hemostasis is important especially in those patients with arteriosclerosis. Through-and-through abdominal sutures can be life-saving when speed is essential and the patient's condition has suddenly become critical.

CAUSES OF OPERATIVE DEATH

Pathologic conditions in the aged are so multiple and varied that it is often difficult to state the cause of operative deaths, even after autopsy. The clinical impression of the major contributing causes of such deaths is heart failure and/or bronchopneumonia accompanied by pulmonary edema. This impression is supported by a review of 55 autopsy records of postoperative patients between the seventh and tenth decades. This showed that all had some type of myocardial or valvular involvement, with frequent cardiac dilatation, and that 39 (70 per cent) had bronchopneumonia and pulmonary edema. In addition, all the patients had varying degrees of coronary sclerosis

with old myocardial damage. There was a recent myocardial infarct in only one instance. These observations seem to indicate that coronary sclerosis *per se* is not a contraindication to operation.

Among other more frequent causes of operative death are shock, sepsis, pericarditis and peritonitis; pyelonephritis and uremia in urologic cases, cerebral thrombosis, pulmonary embolus, malignant metastases, miliary tuberculosis and nutritional and hepatic failure.

PSYCHIATRIC CONSIDERATIONS

The old patient is apt to be stubborn and resistive and grooved in an habitual way of living. Life-long abnormal traits are usually emphasized in old age. These traits call for limitation of restrictions, patience, tact and a bedside manner which radiates optimism. This optimism is strengthened by interviews with ministers in the various religious groups. This practice has been found to be most valuable. The quick change for coöperation is sometimes astonishing, especially in obtaining consent for operation. A persistent lack of coöperation, along with eccentric traits, habits and mannerisms implies the presence of a psychiatric condition. Its recognition is important. If behavior and abnormal habits are extreme, the patient may be misunderstood, the morale of surrounding patients suffers and ward discipline is upset. Among the more usual psychiatric disorders are those caused by cerebral arteriosclerosis and cortical atrophy, senile dementia or involutional melancholia. Some of the manifestations of these conditions are mental rigidity, irritability, intolerance, memory defects, confusion of ideas, disorientation, lack of assurance, tremors, auditory and visual hallucinations, paranoid trends, assaultiveness, and foul fecal and urinary habits. Under such circumstances, transfer to a psychiatric institution is not only advisable but mandatory.

ANESTHESIA

A major factor in the increasing success of geriatric surgery is improvement in anesthesia. The highly specialized anesthetist is well trained in the basic sciences, especially physiology and chemistry. He understands the newer concepts of shock and the various methods for its prevention and therapy. The choice of *the* anesthetist is important. Anesthesia apparatus delivers inhalants scientifically and with reasonable accuracy. The choice of anesthesia is made after consultation between the surgeon and anesthetist. Preliminary sedation minimizes anxiety and shock and reduces the amount of anesthesia necessary.

The success of local anesthesia is dependent on its technical application and the patient selectees. For example, local anesthesia is highly satisfactory in procedures for decompression of abdominal viscera, the repair of inguinal herniae and the excision of superficial growths. The use of novocaine 1 per cent, without the addition of adrenalin, is to be preferred because the adrenalin tends to make the patient excitable and nervous. It is also better to detect

and to tie bleeders than to promote temporary blood vessel constriction by adrenalin.

Spinal anesthesia, with its various refinements, is very helpful in prolonged lower intra-abdominal procedures and in amputation of the lower extremities. It is contraindicated in patients with organic disease of the central nervous system and in those with deformity or arthritis of the spine. It is also contraindicated in those with marked hypertension or nephritis, where the accompanying drop in blood pressure may cause an acute suppression of renal function.

All inhalation anesthesias should be accompanied by ample oxygenation. Cyclopropane seems preferable to all other inhalants. It is least toxic and produces the smoothest postoperative recovery. Ethylene has been discontinued because of its explosive risk and tendency to produce anoxia. Ether, administered by the open drop-method, is still a good supplemental and stimulating anesthetic. Nitrous oxide and oxygen has its usefulness for short anesthesias.

Avertin anesthesia in the aged should be used with a great deal of caution. It is contraindicated in those with diminished cardiac reserve, liver disease, chronic pulmonary conditions and in those who are in shock. If the patient does badly during operation, it is difficult to prevent further action of the avertin and he may just "sleep away."

The intravenous use of sodium pentothal for short operative procedures is gaining favor.

Crymal anesthesia for lower extremity amputations offers a paradox. The technic of its application calls for the obliteration of the blood supply to the extremity by a tourniquet high up in the thigh and for the freezing of the extremity by encasement in ice. These extend over a period of from two to three hours. It is to be expected that the resulting tissue anoxia and its thermal insult at the site of amputation might produce gangrene or poor healing of the stump. These do not seem to occur. Tissue destruction is apparently no more marked than after other methods of anesthesia. If crymal anesthesia is properly carried out, amputation should be painless except that in some patients section and traction on the sciatic nerve produces transient pain. Frequent pulse, temperature and blood pressure readings, before, during and after the operation indicate remarkably little change in these readings from the normal of the patient. It is safe to conclude, therefore, that the operation produces a minimum of immediate or delayed shock. After crymal anesthesia, postoperative phantom peripheral pain is absent or minimal.

GENERAL OBSERVATIONS

Trauma frequently produces undue severity of a lesion and its accompanying ecchymosis. Pain sense, as a rule, is less than the pathologic lesion would seem to indicate. This is especially true in patients with neurologic conditions. There is a marked hyposensitivity to peritonitis, with minimal ab-

dominal muscular rigidity but the temperature is usually markedly elevated. As a result, clinical syndromes may be masked. A thin abdominal wall with lack of tone and panniculus imply prolonged malnutrition and/or hypoproteinemia and predispose to abdominal disruption and poor healing of suture lines. There are surprisingly few wound disruptions and infections, despite the fact that patients often remove their dressings. Postoperative recovery is usually smoother than is generally believed. A persistent drop in blood pressure is a grave sign. Postoperative pneumonia is usually of a diffuse bronchopneumonia type, with minimal or no chest signs, little if any cough and with elevated temperature. The only positive indication of pneumonia may be the roentgenologic findings. The sulfonamides and penicillin are well tolerated and very effective. Since severe medicinal depression diminishes oxidation, motility and secretion it is advisable to use caution in giving sedatives. Morphine and its derivatives can be given in smaller than the usual doses, but demerol as a substitute is becoming more popular. Postoperative use of the barbiturates should be avoided. They tend to cause mental confusion, disorientation and somnambulism. Chloral and bromides are preferable. In old people especially, hot, humid weather is a contraindication for elective procedures.

SUMMARY

1. Experience in geriatric surgery in very bad-risk patients over 60 years of age in a municipal hospital is described. In 450 major operative procedures, 13 per cent of which were emergency, the operative mortality was 22.6 per cent. These, combined with 2,108 major operative procedures in the aged in five other clinics produced an average mortality of 13.1 per cent for 2,558 cases. This rate is not prohibitive when compared with operative mortality statistics in all age groups from five clinics after various major operations. The aged stand operation far better than is generally believed. Advances in medicine and surgery have made this possible.

2. The classification of people past the age of 60 as chronologically or biologically old depends upon the degree of the degenerative processes.

3. Geriatric surgery is growing in importance because of progressive increase in life-span.

4. Familiarity with medical problems and the basic sciences in relation to geriatric surgery is necessary.

5. The surgical risk should not be a deterrent to operation when the surgical disease threatens physical comfort, comparatively normal routine or life.

6. The chief contributing causes of operative death are heart failure and/or bronchopneumonia and pulmonary edema.

7. Coronary sclerosis *per se* with secondary old myocardial damage without decompensation is not a contraindication to operation. Acute coronary occlusion after operation is infrequent.

8. General and psychiatric considerations and general observations in geriatric surgery are noted.

9. A major factor in the increasing success of geriatric surgery is the improvement in anesthesia. Consultation between the surgeon and anesthetist is important.

10. Geriatric surgery can "add life to years and years to life."

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WOUND HEALING WITH LOW VITAMIN C LEVEL

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OUR FIRST EXPERIENCE in the treatment of war wounds was in the Italian campaign in November, 1943. The lines during the next few months were to remain relatively stable and the conditions offered many possibilities to study wounds. The diet of the soldier prior to admission had been uniform and simple. Fighting was in the mountains and the transportation difficult, so that a concentrated diet was necessary. It happens that all of the vitamin C content of this diet is contained in a form of lemon powder which is not relished by the troops and so usually discarded. An opportunity was offered to see the effect, if any, on the plasma levels of vitamin C and any correlation with healing of wounds.

Experimentally, a definite relationship has been established between wound healing and ascorbic acid intake in the scurvy-susceptible guinea-pig.[1] Taffel and Harvey,[2] in an excellent series of experiments, showed that the tensile strength of the stomach of the scorbutic guinea-pig was much less than the normal animal. In man the correlation has not been convincing. The recent literature reflects the amount of interest that has been shown in the subject. With its known prolonged absence producing the clinical picture of scurvy, an attempt has been made by many to correlate a lower intake of the vitamin and low plasma levels with less severe tissue alterations.[3] Minot[4] has stated that a normocytic anemia is produced by a deficiency of the vitamin. Liu[5] showed that the anemia occurring in a group of patients that had low ascorbic acid level responded only with administration of iron and not with ascorbic acid. The response was determined by a rise in erythrocyte and hemoglobin levels.

Resistance in infection and prevention of bleeding gums are some other properties that have been ascribed to this substance. Of particular interest to us has been the observations on wound healing as related to vitamin C. Ingalls,[6] one of the earlier investigators in this field, prepared the following table for vitamin C nutrition as based upon plasma determinations (Table I).

Most of the textbooks[7, 8] give the average level of human plasma as 0.70 to 1.0 mg. per cent.

Pijoan and Lozner[9] have recently written a summary on the physiology of vitamin C in man. They quoted the work of Butler and Cushman,[10] who determined that the ascorbic acid content of the white cell-platelet layer of centrifuged blood is probably the most accurate indication of prescorbutic status. The normal is 25 to 38 mg. per 100 cc. of this layer. Pijoan maintained himself on a low ascorbic acid intake for 20 months with 0.0 to 0.2 mg. plasma ascorbic level. The white cell-platelet layer, on the other hand, was always above the 25 mg. per 100 cc. An experimental wound at the end of this time showed normal healing. Crandon, Lund and Dill[11] showed that the normal healing of an experimental wound on a normal adult occurred

after the plasma ascorbic acid had been 300 for 44 days and the white cell-platelet layer was 4 mg. per 100 cc. It was after the white cell-platelet layer had been 300 for two months that a second wound failed to heal clinically, and, histologically, showed a lack of intercellular substance.

In this study it was possible to obtain the exact diet of the individual for 30 days prior to the receipt of his wound. It was found that in most incidences the diet was the same for much longer periods of time but one month was as long as most patients could recall the type of ration they had eaten.

The types of ration that were used by the subjects in this study are as follows:

TABLE I

VITAMIN C NUTRITION AS BASED UPON PLASMA DETERMINATIONS

State of Vitamin C Nutrition	Plasma Ascorbic Acid Mg. Per Cent
Optimum:	
Saturation	2.00—1.00
Normal	1.00—0.70
Low normal	0.70—0.50
Suboptimal	0.50—0.30
Deficiency:	
Asymptomatic scurvy	0.30—0.15
Clinical scurvy	0.15—0.00

Ration C.—This is the simplest form of ration. Each meal is the same, and is packed in two cans. One contains either meat and beans, hash or meat and vegetable stew. A second can has biscuits, candy, sugar and a package of either cocoa, coffee, or lemon powder. The ration can be quickly heated and requires no equipment for preparation. The monotony is its principal disadvantage. The entire ascorbic acid content is in the lemon powder, which is provided in one-third of the cans containing biscuits. This is designed to give each man 70 milligrams of vitamin C daily. (The C ration has been subsequently modified.)

Ration K.—This is a similar type of field ration which is designed for the use of the individual. It is contained in small cartons that are easily carried by the soldier. It offers a further change in the foods for each meal. The main items are a can of meat and eggs for breakfast, cheese for lunch and a can of meat for supper. It, likewise, offers the ascorbic acid in the form of lemon powder. This is packed in the noon meal box. The amount is 60 milligrams.

Five-in-One and Ten-in-One Rations.—These rations, as the name implies, are issued in bulk to supply either five or ten men. They group their food supply and thus obtain a better variety of more palatable foods. Five different variations or menus are offered with this ration. It is combined with the issue of cigarettes, soap, and water disinfectant tablets. In the five-in-one type, fruit juice is given daily and the lemon powder is issued in only one meal of one menu. In the ten-in-one type, all menus contain

fruit juice powder. Both are calculated to give each man 75 milligrams of vitamin C daily.

Theater "B" Rations.—This type is used in the sections where troops are located in regular camp areas or in buildings. The facilities for cooking and storage of food are good. Many of the units are able to purchase fresh vegetables in the markets, but, in general, there is still a predominance of canned foods. The lemon powder is furnished in bulk and is to be added to the fruit juices which are served. This is the type of ration used for the various hospital installations in this area. The minimal intake of ascorbic acid is again calculated at 60 milligrams. This factor would vary markedly from season to season and in the manner of preparation of the food in the different installations.

The cases in this study were all admitted to the hospital during the latter part of February and the month of March, 1944. The only requirement was that they had been at the front for 30 days or longer. They were

TABLE II

SUMMARY OF THE EATING HABITS OF THESE PATIENTS

Number of patients eating three meals daily	78
Eating the entire amount of food of each meal	46
Eating occasional green food	26
Using the lemon powder occasionally	14
Using the lemon powder consistently	2

selected at random on admission. Information was obtained regarding the number of meals eaten, average part of each meal consumed, if the lemon powder were used, supplemental rations as regards green foods, *etc.*, estimated weight loss, bleeding of gums and appetite. At physical examination, the general state of nutrition, hydration, condition of gums and skin was noted. A record of the case, diagnosis, extent of the wounds and the hospital course was recorded. The tourniquet test was tried on many of the earlier cases but was abandoned. No hemorrhages were observed. A fasting blood sample was taken and within three hours a determination of the plasma vitamin C was made using the technic of Farmer and Abt.[12] Hemoglobin determinations were made using the chemical method of Wong.[12] Plasma protein and hematocrit values were determined by the copper sulfate specific gravity method, as described by Phillips, Van Slyke, *et al.*[13]

Of the 100 soldiers examined, 68 had wounds. The latter had an average of 2.6 wounds per patient. These were divided into 43 "mildly" wounded, *i.e.*, having usually one or two wounds of the soft tissue and 25 cases of "seriously" wounded, having extensive injuries and multiple wounds often associated with fractures. Thirty-two of the cases had trench feet and the others had miscellaneous diagnoses.

The average soldier in this group had ration C for nine days, ration K for nine days, five-in-one for seven days, ten-in-one for two days and ration B for three days.

Twenty reported their appetite as poor, 21 as fair, and good in 59. The information as regards weight changes is not reliable. An estimate only was obtained. For the 30 days prior to admission, 25 noted no change in weight, 21 had estimated a loss of five pounds and 21 were estimated at ten pounds. One had gained three pounds and two had stated their loss as 20 pounds.

No case of clinical scurvy could be demonstrated. There was encountered no unusual hemorrhage in the skin and the only abnormal condition of the gums was that usually seen with pyorrhea.

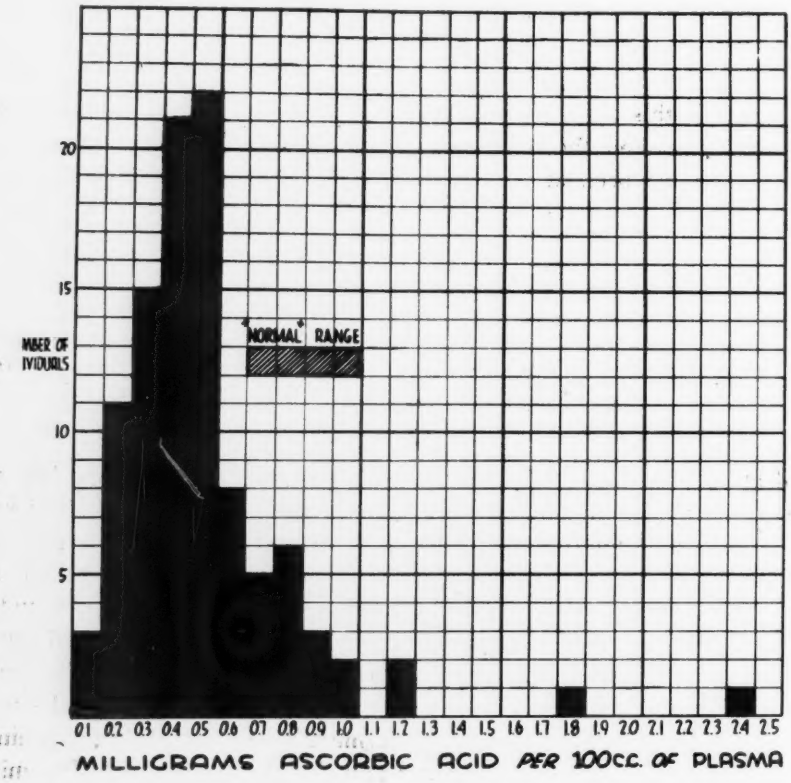

CHART I.—This shows the distribution of plasma ascorbic acid values for 100 soldiers.

The admission plasma vitamin C levels of the 100 patients varied between 0.1 mg. and 2.35 mg. per cent. We were unable to account for the latter unusually high figure. The next highest figure was 1.1 mg. per cent, and this soldier had been able to obtain two oranges a day for the month prior to admission. Seventy per cent were in the range of 0.2 to 0.5 mg. per cent. The mean level for the entire group was 0.631 mg. per cent. The results are shown in Chart I.

To determine if the diet in an installation would maintain a high fasting plasma ascorbic acid, ten men were selected at regular intervals from the roster of the hospital personnel. These men had been on a "B" ration for

five months. The average level for the group was 0.585 mg. per cent. The lowest was 0.2 mg. and the highest 1.2 mg. per cent.

Determinations were repeated on 13 of the seriously wounded after a period of six weeks hospitalization. The results are shown in Table III.

TABLE III

DATA ON REPEATED VITAMIN C DETERMINATIONS ON 13 PATIENTS

Patient	Vitamin C Level on Admission	Vitamin C Level after 6 Weeks
2	0.2	0.6
3	0.2	0.7
5	0.9	0.9
7	0.4	0.5
8	0.4	0.6
9	0.3	0.4
10	0.4	0.6
13	0.5	0.8
14	0.3	0.5
16	0.4	0.6
20	0.5	0.9
21	0.6	1.4
23	0.5	0.3
Average	0.43	0.68

Of the 43 less seriously wounded, or patients having operative incisions, only two failed to heal. In these it was necessary to perform additional closure of the wound or apply a skin graft to cover the defect. In the first of these failures, one-half of one wound separated, while another wound of the same size and severity healed promptly. The blood findings on admission were: ascorbic acid 0.2 mg. per cent, plasma protein 6.8 mg. per cent, hemoglobin 86 per cent, and hematocrit 40 per cent. The other patient had a secondary closure of a perforating wound of the left thigh which separated. An additional closure of the wound was successful. His blood findings on admission were: ascorbic acid 0.43 mg. per cent, plasma protein 7.87 mg. per cent, hemoglobin 111 per cent and hematocrit 54 per cent. One patient not included in the failures had an abscess of a puncture wound of the knee region on admission. The wound for incision and drainage of the infection healed promptly. The ascorbic acid level was 0.1 mg. per cent. Another complained of vague abdominal symptoms and epigastric pain. An examination of the gastro-intestinal tract by a barium meal showed intestinal patterns which were interpreted as "avitaminosis." His ascorbic acid level on admission was 0.5 mg. per cent. The course of another in this series was complicated by acute hepatitis associated with jaundice.

Of the 25 seriously wounded patients six failed to heal primarily. It is of advantage to report these cases more in detail.

CASE REPORTS

Case 1.—A 21-year-old soldier was admitted, April 4, 1944, with extensive wounds of the right lower thigh, chest, a penetrating wound of the right foot and traumatic amputation of the left leg, sustained March 25, 1944. The ascorbic acid level on admission was 0.2 mg. per cent. The second day after admission the wounds of the right

thigh were closed and a graft applied to the stump of the left leg. All wounds of the thigh healed promptly. The graft was lost at the end of two weeks. On April 27, the left leg was reamputated and healed under penicillin protection. The ascorbic level was 0.6 mg. per cent May 18, 1944.

Case 2.—A 19-year-old litter bearer was admitted, April 4, 1944, with penetrating wounds of the left shoulder, comminuted fracture of the scapula, extensive wounds of the left chest and buttock, a midthigh amputation of the left leg. On admission, ascorbic acid level was 0.2 mg. per cent. Following a delayed primary closure of the wounds April 6, all healed except the one of the left stump. Under penicillin protection April 24, an additional closure and skin graft operations were done. May 10, there were a few small unhealed areas. The ascorbic acid level on May 19 was 0.7 mg. per cent.

Case 3.—A 20-year-old rifleman was admitted, April 4, 1944, having been wounded in action March 26. The diagnoses were: (1) Extensive wounds of the right thorax, with a fracture of the tenth rib and penetration of the diaphragm, liver and kidney; and (2) multiple wounds of the right arm, with extensive comminution of elbow joint. Ascorbic acid level on admission was 0.5 mg. per cent. April 6, all of the wounds were closed. Two days later the distal humerus and the proximal portions of the radius and ulna were resected. All wounds healed except for a slight disruption of the abdominal wound. No sutures were required to close the defect. No further blood determinations were done.

Case 4.—A 27-year-old artilleryman sustained, February 19, 1944, a severe wound of the inguinal region dividing the femoral vein and artery. His ascorbic acid level on admission, February 22, was 0.5 mg. per cent. February 25, a delayed primary closure was done. This promptly separated. March 23, the lumbar sympathetic ganglia were removed from the wounded side and this wound, likewise, became infected and separated. The ascorbic acid level at the time of this complication was 1.1 mg. per cent. He was returned to the States on June 1, at which time his wounds remained unhealed.

Case 5.—This case was of unusual interest. A 24-year-old infantryman was admitted April 4, 1944. Admission level of ascorbic acid was 0.5 mg. per cent. He had wounds of the left shoulder and both scapular regions, wounds of the lumbar regions and the elbow. April 5, all wounds were closed and healed except that of the left shoulder. May 5, an additional closure of the shoulder wound was done. At the same time a pigmented nevus was removed from a clean area of the ankle. May 18, both wounds completely separated and, as described by the operator, "without apparent reason." The ascorbic acid level at the time of the second separation was 0.9 mg. per cent.

The level of the ascorbic acid for the group of wound failures, on admission, was 0.37 mg. per cent. The average admission level for the remainder of the seriously wounded soldiers, who healed promptly, was 0.45 mg. per cent. Of the 25 seriously wounded 21 returned to the States. In no instance were they evacuated due to failure of wound healing but because of loss of an extremity, severe chest injuries, brain injuries or extensive fractures requiring prolonged treatment. In the group of seriously wounded it is significant that only one or two wounds failed to heal while others healed readily.

Plasma ascorbic acid levels were determined on nine patients that had wounds that failed to heal. Some of these wounds had been closed several times by different operators. Most of this group were hospitalized for two to three months. The first three cases were during the spring months and

the latter six were during the fall, following a period in which the hospital diet had contained fresh fruits and green vegetables. Table IV is a summary of the findings.

TABLE IV

ASCORBIC ACID LEVELS ON PATIENTS WITH REPEATED WOUND FAILURES

Wound of:	Date of Admission	No. of Operative Closures	Ascorbic Acid Mg. Per Cent	Date of Determination
Lumbar region	Jan. 21	3	0.50	Apr. 13
Lower leg	Jan. 30	2	0.50	Apr. 13
Upper arm	Jan. 26	3	0.80	Apr. 13
Thigh	May 26	5	1.26	Nov. 20
Upper chest	Sept. 23	4	1.31	Nov. 20
Posterior chest	Oct. 25	2	1.44	Nov. 20
Posterior thigh	Oct. 13	3	0.64	Nov. 20
Lateral thigh	Oct. 17	2	1.11	Nov. 20
Posterior chest	Oct. 17	3	0.84	Nov. 20

DISCUSSION.—In this study, 100 soldiers were selected on their admission to the hospital. These men for at least one month had been at the front on a ration of concentrated foods. Practically no green foods were obtained. Their entire source of vitamin C was ascorbic acid contained in the lemon powder. This was discarded by all but 2 per cent of the troops. The fasting plasma ascorbic acid levels were obtained the first day after admission and were found, in general, to be below the "normal" minimal range. The diet in this hospital was unable to raise the level appreciably to so-called "normal" levels, as shown by repeat determinations and determinations of hospital enlisted personnel.

Of the 100 men, 68 had wounds and eight of this number had interference in healing and required an additional operative procedure to close the skin defect. This is a failure in 11.7 per cent. Nine patients having repeated wound failures showed no reduction in the plasma ascorbic acid levels.

With added experience in the closure of war wounds it has become possible to avoid many of the causes of failure of wound healing. Most of the instances in this group were associated with infection. It is interesting to note that the one case in which no explanation could be given for the separation of a "clean" wound the ascorbic acid level was 0.9 mg. per cent. Improvement in delayed primary closure of wounds has followed the following principles: Early and adequate débridement; use of incisions at the time of débridement that readily lend themselves to closure, proper splinting of the wounded part; early (four- to five-day) closure of the wound in the operating room at the time of the first dressing by suture or skin graft; use of fine nonabsorbable suture material closing the skin only and without tension; the maintenance of normal blood constituents especially as regards the plasma protein, hematocrit and hemoglobin levels; and the intelligent use of penicillin and the sulfonamides. We have found during the past year that the improvement in wound healing has been from these measures. In general, no therapeutic doses of vitamin C have been given. The diet of the soldier has remained the same, yet there has been a continued decrease in

the number of wound failures. This has improved until Kirtley and Trabue,[14] of our group, report an incidence of 4.2 per cent of infections in 71 wounds having delayed primary closure four to six days after débridement. Crutcher[15] collected a series of 100 consecutive cases closed from three to ten days following débridement, with separation in only two cases. Those with mild "stitch" abscess were not included.

SUMMARY

1. One hundred patients were studied that had been on a diet for one month, or longer, that was deficient in vitamin C.

2. No clinical evidence of vitamin C deficiency was found.

3. Plasma ascorbic acid values on admission varied between 0.1 mg. to 2.4 mg. per cent. The mean level was 0.63 mg. per cent. Sixty-nine per cent of the patients were within the range of 0.2 mg. to 0.5 mg.

4. Of a group of 43 less seriously wounded, only two patients had wounds that failed to heal.

5. Of a group of 25 seriously wounded, there were six failures.

6. Nine selected patients, with repeated wound failures, had plasma level findings of 0.5 mg. to 1.44 mg. per cent, with a mean level of 0.93 for the group.

7. No relationship between plasma ascorbic acid levels and wound healing was observed.

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ANNOUNCEMENTS

Department of Anesthesia at McGill University

Recently there has been created in McGill University, Montreal, Canada, a Department of Anesthesia.

The objects of this newly-established centre of learning for anesthesia are: (1) to improve the teaching of anesthesia to the undergraduate students in Medicine; (2) to increase the opportunities for learning anesthesia among the internes of the hospitals connected with the university; (3) to conduct a three-year Diploma Course in Anesthesia; and (4) to develop investigation in anesthesia in the Clinic and in the Laboratory from the point of view of interrelationship, and, as well, in an interdependent fashion with the University's other departments.

It is considered that THE CENTENARY OF ANESTHESIA is being celebrated in a practical manner, and an international attitude is being adopted at the very beginning.

THE EDWARD D. CHURCHILL LECTURE FOUNDED BY THE EXCELSIOR SURGICAL CLUB

A GROUP OF SURGEONS, who formerly served as members of the U. S. Armed Medical Corps in the North African and Mediterranean Theaters of Operations, recently organized The Excelsior Surgical Club. Patterned somewhat along the lines of the Eclat Club which, in a comparable manner, grew out of World War I, The Excelsior Surgical Club has as its objectives the promotion of the social intercourse of the members and the advancement of their knowledge of the science of surgery.

A principal and outstanding activity of the Club is to be the Edward D. Churchill Lecture honoring the former Surgical Consultant of those Theaters, Dr. Edward D. Churchill, John Homans Professor of Surgery at Harvard University. The Lecture, to which the medical public will be invited, will form an integral part of each annual meeting. The Club plans that each Lecture will be a foremost scientific presentation. To that end, Dr. Alfred Blalock, Professor of Surgery, Johns Hopkins University, has been secured to give the first Churchill Lecture at the first regular meeting of the Club in Boston on October 25–26, 1946.

BRIEF COMMUNICATION

MODIFIED BAKEŠ COMMON DUCT DILATORS

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ROCHESTER, N. Y.

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NATURE has laid a trap for the surgeon by placing the lower end of the common bile duct in such an inaccessible position that stones cannot be seen nor easily felt. Indirect instrumentation is required for their removal with scoops or forceps after which there is always the question if any remain. This may be tested by the catheter-saline method of Cheever,[3] or by probing the duct to test its patency. The instrument designed by Bakeš is very useful for this purpose, for the smallest size (3 mm.) makes an excellent probe and the larger

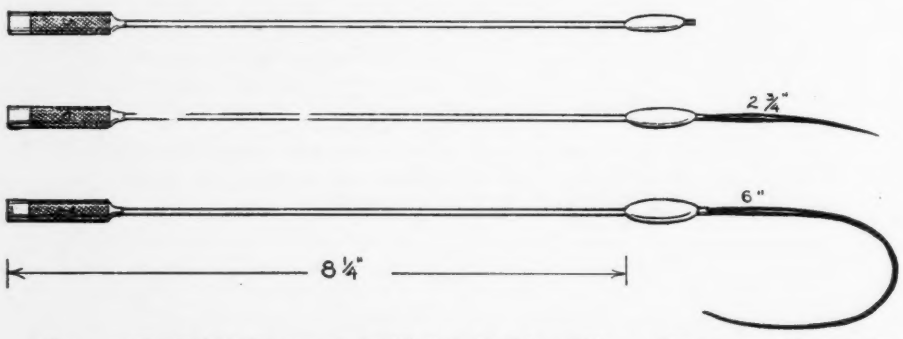

FIG. 1.—The Bakeš dilators as modified to include a filiform. The type of thread, the short and the long filiforms are shown from left to right. The flexible handle has been lengthened to 8.25 inches for greater ease in manipulation.

ones (4 to 6 mm.) assist in palpating the duct and sounding the ampulla. The operator may locate a stone by feeling along the duct as the dilator is slowly passed down it. He may define the borders of the ampulla of Vater quite accurately by placing a dilator in it and feeling through the anterior duodenal wall. Finally, the passage of the dilators into the duodenum sounds-out the size of the ampulla.

One fault of the Bakeš dilators is the lack of a guide to the ampullary orifice. This occasionally leads to their being caught in a false passage or in a mucosal fold and not passing into the duodenum, giving the erroneous impression of duct obstruction. The obvious solution of this difficulty is to attach a filiform to the end of the dilator to act as a guide. Desiring this, the author asked V. Mueller and Co. to make dilators from 3 mm. to 7 mm. size (Fig. 1) with a standard thread. The ordinary filiform used in urology is 12 inches in length, which is too long for this purpose. Two special filiforms are available; a short 2.75-inch (7 cm.) size and one that is six inches long.

The short one is fastened to each dilator before it is passed. The six-inch filiform may be left with the tip in the duodenum as each successive dilator is attached to it just as is done with a filiform and followers in urology.

The metal base of the filiform when attached to the dilator makes the rigid part of the instrument slightly longer. This is a little awkward with a high opening in a common duct tucked up under an overhanging liver, for it is harder to make the turn into the duct. However, this occasional disadvantage is slight in comparison to the benefits derived from having a guide to its passage.

Bakeš called this instrument a dilator,[2] and he, and others,[1] used it for stretching the ampulla of Vater. However, the experiments of Zollinger, Brauch, and Bailey[4] have clearly shown that this not only causes edema, hemorrhage, scarring, and increased intraductal pressure but also does not give any permanent enlargement of the opening. No instrument larger than 7 mm. (22 F.) should be passed through the ampulla, and even this size should not be used if any force is required.

SUMMARY

The Bakeš dilator is an exceedingly valuable instrument for exploration of the common duct and ampulla of Vater. It is modified to include a filiform in order to expedite its passage into the duodenum.

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BOOK REVIEWS

PATHOLOGY IN SURGERY. By Nathan Chandler Foot, M. D., Professor of Surgical Pathology, Cornell University Medical College; Surgical Pathologist, New York Hospital. 500 pages, 368 illustrations in black and white, and 20 subjects in full color on ten plates. Philadelphia, London, Montreal, J. B. Lippincott Co., 1945.

ONE of the most interesting and important developments in American medicine during the past 20 years has been the establishment of the various Specialty Boards and the effect these have had in raising the standards of specialty education and practice. Most of the boards in the field of surgery and diagnosis require of their candidates a certain amount of training in the pathology of surgery, and include this subject in their examinations. Inevitably, this has led to a demand for postgraduate study in this topic—a demand which is becoming increasingly difficult to meet because of the dwindling number of competent teachers of pathology and the dearth of satisfactory texts of surgical pathology. Therefore, it is a pleasure to welcome this handsome volume from the pen of a leader who is known for his technical contributions and the breadth of his ripe knowledge.

Doctor Foot has not attempted to cover the entire field of surgery, and those who seek to know in detail the full pathology, for example, of the skin, nervous system and organs of the special senses will not find it here but must consult special monographs dealing with those subjects. Nor does he do more than touch upon some features of general pathology, which he feels are adequately dealt with in such standard texts as Karsner's "Human Pathology." He wishes his monograph to be regarded as ancillary to that excellent work, and Lippincott's have used the same easy reading format in manufacturing the present volume.

The medical student, the practicing surgeon and general pathologist will find this monograph a most valuable adjuvant to the study and interpretation of the pathology of the surgical diseases. As with any attempt to compress an enormous body of knowledge within the covers of a single volume, the expert will find some omissions, which he may regret, and occasional statements with which he will not be in full agreement yet, on the whole, it would be an act of invidious pejoration to single these out when the work, as a whole, is of such a high order. Most of the fundamentals will be found here and the references will serve to guide those seeking more detailed information, although some of them are not as recent as they might be. This reviewer who is well acquainted with the multiple facets of Doctor Foot's versatility is happy to be afforded the opportunity thus publicly to offer his congratulations upon the appearance of this latest example of his lucubrations.

ARTHUR PURDY STOUT, M.D.

Textbook of Obstetrics. By Henricus J. Stander, M.D. 9th Edition, D. Appleton-Century Co., New York, 1945.

WITH THE PUBLICATION of this retitled edition, little remains of the original text which was first published in 1903 and has been constantly revised, rewritten, reillustrated and modernized through nine editions and 46 printings. Every effort has been made, by the authors and publishers to improve the book in each edition, to the end that it might maintain its reputation as an authoritative presentation of obstetrical principles and the most modern guide to conservative obstetrical practice. The final result of this truly amazing modernizing process, the 9th edition, practically constitutes a new textbook—Stander's Textbook of Obstetrics.

To write a worth while textbook requires that the author shall be a good teacher—the better to plan consecutively; think logically; write clearly and concisely; and where

illustrations are to be employed, illustrate intelligently. This volume with its 1,287 pages of written text and nearly 1,000 illustrations, many in color, demonstrates the validity of these statements.

The general physical plan of this present edition differs quite radically from the previous editions of the William's Obstetrics in that the various subjects are presented in sections and subheadings instead of chapters. This idea seems reasonable because by this system there should be no confusion to either teacher, student or practitioner who wishes to utilize basic principles, didactic instruction or clinical procedures—singly or in combination. Furthermore, in order to facilitate and simplify reading matter, small type is employed to more sharply separate historical or purely theoretical considerations from the main text—a time-saver for the busy practitioner or the hard pressed undergraduate student. Likewise, the indexing system has been improved—made more readily workable.

It has been very aptly said that the illustrations in a textbook either make it a "best seller" or relegate it to the bookseller's shelf. This, it seems to this Commentator, is particularly true of obstetrical textbooks; and for two very good reasons: (1) basic obstetrical facts, *e.g.*, anatomy, embryology, physiology, pathology, *etc.*—can better be elucidated through good illustrations; and (2) obstetrical operations can be demonstrated much more satisfactorily through the medium of graphic drawings, made by a competent artist. Stander's illustrations are distinctly superior. They are the work of well-recognized medical artists; they are of sufficient size to give real instructional detail; and are so numerous as to almost constitute in themselves an obstetrical atlas. Those by the late Max Bröedel, the master medical illustrator, deserve special mention. Indeed, the author of any textbook containing Bröedel illustrations—father or daughter—is most fortunate.

Throughout this 9th edition, the author has kept the undergraduate student, as well as the practitioner in mind, deleting and adding such material as would make for completeness, readability and up-to-the-minute information. Among the outstanding sections might be mentioned those on the management of normal pregnancy with particular emphasis on the adequate antenatal care; the conduct of normal labor; the pathology of pregnancy; abnormal pelves; particularly the sections on clinical and morphologic classifications and clinical and roentgenologic pelvimentry; the management of obstetrical difficulties; and the pathology of the puerperium. The importance to the obstetrician of anesthesia; the toxemias of pregnancy; the management of hemorrhage, both ante- and postpartum; chemotherapy in the presence of acute infection; and the prevention and proper treatment of asphyxia neonatorum, cannot be over emphasized. These subsections are particularly well discussed, and if the practitioner and student, especially the former, would follow explicitly the information herein given, our present maternal and fetal morbidity and mortality rates could be still further reduced.

Bibliographic references are a necessity for the modern textbook. Stander's book is outstanding in this respect. However, this Commentator wonders whether the Author has not overburdened this portion of his book with quite a number of outdated references. There are a total of 106 pages of references, some old; some "middle-aged," and literally hundreds that are strictly up to date. The latter, without question, being indispensable in usefulness and value. On the other hand, would it not be more in keeping with the general modernization plan of the volume to sift out a goodly number of these old references? For example, there are 147 references on the Anatomy and Physiology and Development of the Ovum; 209 for the physiology of pregnancy; and 297 on the toxemias of pregnancy. It seems reasonable that not a few of these particular references might be deleted without detracting from the completeness of the section to which they pertain. The same comment could be applied to other sections of the book. However, it is without doubt true that if one prefers a well-nigh complete bibliography following every section of any given textbook, this 9th edition of Stander's Obstetrics is "tops." It unquestionably gives ready access to a veritable mass of obstetrical information, as well as many allied subjects, which may or may not be indispensably useful depending upon the requirements of the reader and the whim of the publishers.

Incidentally, the publishers of this volume have performed an excellent job. Under wartime conditions, it required much planning and "architectural" skill in bookbuilding to add all the necessary new material to the book and keep within the government's regulations and limitations on paper, ink, printing and binding—not to mention labor costs. It was no simple task to publish a textbook of this character and size, containing nearly 1,000 illustrations, many in color, and keep the selling price at a reasonable figure. All this, the publishers have accomplished in a commendable manner.

In conclusion, it may be well said that Stander's Obstetrics is distinctly outstanding. No one except a logical thinker and an experienced teacher could have performed such an exacting task. In it the undergraduate and postgraduate student; the general practitioner or the specialist has a readable; modern; conservative; authoritative; and splendidly illustrated textbook; which is offered at a price that does not unduly "strain" anyone's budget. It's popularity should continue at an ever increasing rate, which in turn will serve to promote better obstetrics and thus help to continue the downward trend in our maternal and fetal morbidity and mortality rates.

HARVEY B. MATTHEWS, M.D.

EDITORIAL ADDRESS

Original typed manuscripts and illustrations submitted to this Journal should be forwarded prepaid, at the author's risk, to the Chairman of the Editorial Board of the ANNALS OF SURGERY.

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1833 Pine Street, Philadelphia, Pa.

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Exchanges and Books for Review should be sent to James T. Pilcher, M.D., Managing Editor, 121 Gates Avenue, Brooklyn, N. Y.

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ANNALS OF SURGERY

East Washington Square, Philadelphia, Pa.

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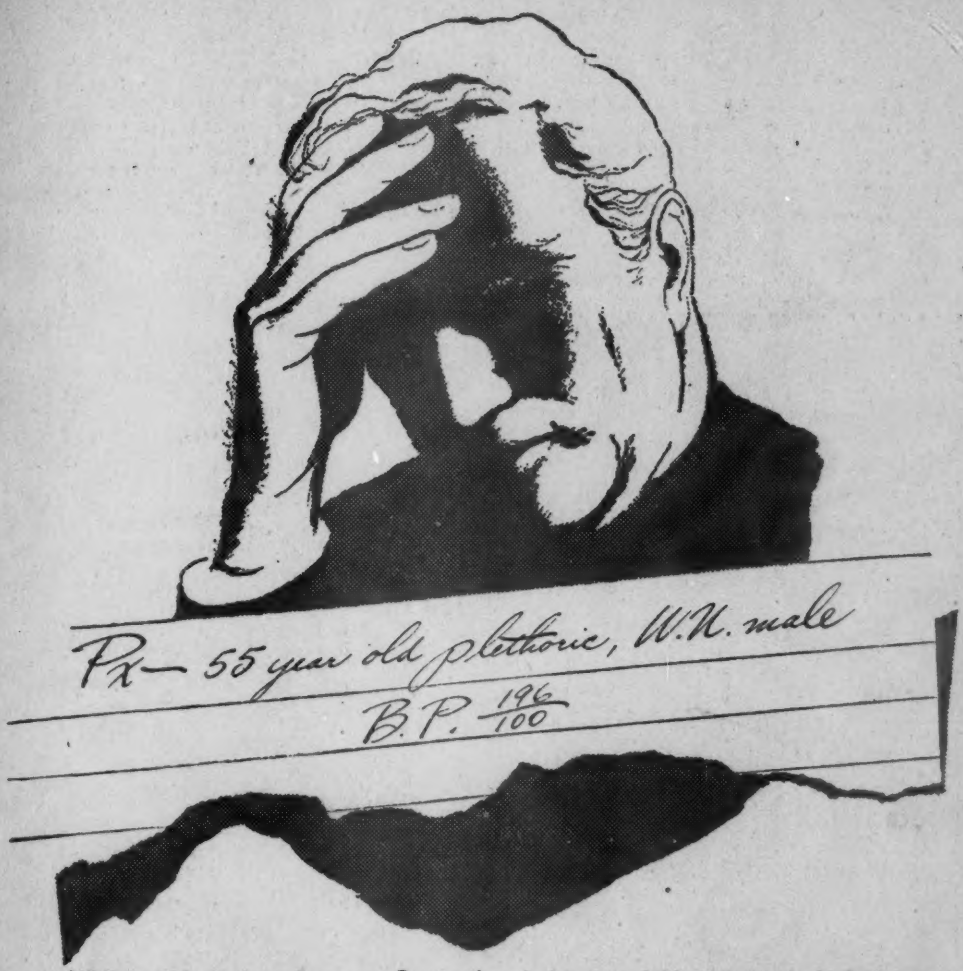

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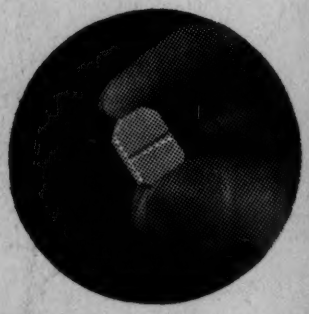

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